Clean Harbors Environmental Services, LLC
Lone Mountain Facility
Waynoka, Oklahoma

RCRA/HSWA Permit Renewal Application

Volume 2

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Lone Mountain RCRA Permit Renewal

Volume 2

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Personnel Training

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1.0 Overview of the RCRA Training Program

It has always been paramount to Clean Harbors' philosophy to provide the safest possible work environment for its employees. The RCRA training program provides facility personnel with the knowledge necessary to understand the processes and materials with which they are working, safety and health hazards, and practices for preventing (and the procedures for responding effectively to) emergency situations. In addition, the program provides the knowledge for using, inspecting, repairing, and replacing facility emergency equipment.

Initial training of employees is completed within six (6) months of their start work date or reassignment, whichever is later. Each employee participates in an annual review of his or her initial training. Continuous instruction in safety is provided through safety meetings and drills. The goal is to have personnel trained to perform their specific job functions in a compliant manner and maintain the facility in a constant state of preparedness.

1.1 RCRA Personnel Training Requirements

Facility personnel must successfully complete a program of classroom instruction or on-the-job training that teaches them to perform their duties in a way that ensures the facility's compliance with the Permit and regulations. The regulations specify a requirement that the program be designed to ensure that facility personnel are able to respond effectively to emergencies, must successfully complete a program of classroom instruction or on-the-job training, and must be trained to perform their duties in a way that ensures the facility's compliance with the requirement of this part (40 CFR Part 264). The regulations require facility personnel to be trained, and for the purpose of this plan, the definition of facility personnel is discussed below.

1.2 Facility Personnel Defined

The regulations regarding facility personnel training require that employees responsible for managing hazardous waste be trained to the degree necessary that they can manage hazardous waste in compliance with the facility's permit and referenced regulations. For the purpose of this training program, the term "facility personnel" applies to those employees who work on-site for the purpose of managing (e.g., waste sampling, storing, treating, disposing) hazardous waste. There are also employees whose job functions do not involve the management of hazardous waste but may affect facility compliance. These persons/job descriptions include secretaries, record clerks, customer relation specialists, equipment mechanics, etc. At a minimum, these personnel will receive training in those areas of their jobs that may affect compliance. Not covered by this training program are persons from other divisions of Clean Harbors, consulting engineers, etc., who do not manage hazardous waste as described above (e.g., geologists, environmental samplers, construction personnel, auditors, etc.). Personnel from off-site who are involved in the management of hazardous waste will either be trained in accordance with this plan or the contractor/employee must certify to the facility that all employees have been properly trained. This certification will be kept on-site in lieu of training records.

1.3 Training Records

Training records are maintained for each employee meeting the definition of facility personnel. Records includes the job title of the employee, a description detailing the requisite skill, education, other qualifications, and duties related to that job title, and the amount of both introductory and continuing training that will be given to that employee. Also included in the file are records that document the training has been completed or job experience is satisfactory.

When personnel miss a refresher course (e.g., due to illness, vacation), they may review that topic with their supervisor, regulatory compliance personnel, or other qualified individuals. Such reviews are documented in the individual personnel training files.

Training records on current personnel will be kept until closure of the facility. Training records on former employees will be kept for at least three years from the date the employee last worked at the facility, except personnel training records that may accompany personnel transferred within the company.

1.4 Off-Site Training

Training is available outside the facility that can serve to fulfill the required training. In some areas, college credits or degrees can serve to exempt a person from further training in a certain area. For example, the Lab Manager will normally have a degree in engineering, chemistry, or other science-related field. This person would not be well served by having to attend a course in "Chemical Terminology, Toxicology, and Handling." In fact, this person may serve as the on-site technical expert in that area. In those cases where a person has expertise in an area, formal education or job experience may be documented and serve as total fulfillment of that particular training need.

In some years, a person may attend an off-site seminar or training course that contains equivalent information contained in one or more of the on-site training sessions. This training may be documented by the trainee (self-certification) and serve as total fulfillment of that particular training need.

Management training often takes place in non-discrete sessions such as corporate staff meetings, compliance meetings, permit application work groups, permit negotiations, or other informal sessions and even self-directed learning sessions. These sessions often are of better quality for managers and can be documented by the trainee (self-certification) and serve as total fulfillment of that particular training need.

In summary, non-Lone Mountain Facility sponsored training may be completed and documented to fulfill the training requirements contained in this plan. The training, if it is to be used as fulfillment of the requirements contained herein, must be documented appropriately.

2.0 Facility Sponsored Training Courses

The training program is centered on the adequate training of facility personnel. Lone Mountain Facility employees are to be trained with safety and environmental protection as the primary concern. Training can be obtained from many sources, and frequent off-site training is encouraged to allow the free exchange of new ideas. However, to ensure that a basic core training program is available to employees, the Lone Mountain Facility sponsors and administers a comprehensive Training Program. The following descriptions are typical of the basic concepts administered through the Lone Mountain Facility Training Program. These concepts may be taught as an entire training course, as part of a single course, or as part of several courses. A list of typical training course descriptions and frequencies is included in Appendix I.

2.1 Company Orientation

All personnel, upon initial employment, are introduced to the company philosophy and method of operation as well as specific rules and regulations.

2.2 Chemical Terminology, Toxicology, and Handling

This training provides a basic understanding of relevant terminology and inherent properties of the waste groups managed on-site. Precautions to be taken in handling hazardous wastes and the reasoning for such measures are emphasized. Specific consideration is given to the procedures and practices governing the mixing of materials and prohibiting mixing of incompatible materials that may result in undesired events. As an example, container management personnel will receive training emphasizing storage of ignitable, reactive, and incompatible materials.

Instructions are provided by the Laboratory Manager, approval personnel, regulatory compliance personnel, or other technical representatives. Discussions of toxicology and inherent hazards are tailored to meet the types of materials treated, stored, or disposed of on-site.

2.3 Operating Practices Summary

All operators (e.g., landfill operators, stabilization operators, container management operators) are required to become familiar with the operating practices for their respective units. Each operator will be instructed in the sections of the permit applicable to their unit, and discussions will be held to answer questions. Procedures and actions will be discussed, and actual drills may be performed in the field. Other personnel will be trained, as needed, through orientation or review of relevant plans.

2.4 Contingency Plan

All personnel are required to understand the Contingency Plan to the degree that it affects them and be prepared to put it into action at all times. The Contingency Plan covers response to spills, fires, releases, and other emergency situations. The Plan also discusses notification, evacuation, and clean-up procedures. This area of training includes instruction in the procedures for using, inspecting, repairing, and replacing facility emergency and monitoring equipment; the key parameters for automatic waste feed cut-off systems; emergency communications and alarm systems and signals; response to ground-water contamination incidents; and procedures to be followed in the event of a shutdown of operations, as applicable.

Procedures and actions are discussed, and actual drills may be performed in the field. These periodic drills are held to simulate fires, explosions, or releases of hazardous wastes. Reviews are conducted at least annually and when changes in facility operation or personnel affect the coordinated effort needed for an emergency response.

2.5 Respiratory Equipment

For protection in atmospheres known or suspected to contain hazardous substances, designated personnel are instructed in the care and use of respiratory protection equipment. The training instructor is either a factory representative or an individual qualified due to their job skill (e.g., Health and Safety Officer, regulatory compliance personnel, etc.). Training stresses proper use and fit and procedures for inspection and maintenance. The types of respiratory protection necessary are unique to each activity, depending on the inherent hazards of the materials handled, and the environment/area in which the material is located. For this reason, respiratory protection procedures are reviewed periodically and assessed for additional risk of respiratory insult because of changes in an operation.

Literature available for the respiratory protection equipment is read by and/or reviewed with employees. All repairs and inspections of equipment are performed by trained personnel when and where required. Reviews are held annually at minimum.

2.6 Unit and Equipment Operations

All personnel involved in the operation of hazardous waste management units or process equipment are required to be cognizant of proper operating procedures, emergency procedures, and maintenance particular to the unit or machinery he or she operates. Initial training covers operation of new or unfamiliar units, processes, or pieces of equipment. However, experienced personnel are also required to review the training topics (e.g., Safety Meetings).

3.0 Implementation of Training Program

The implementation of the training program is demonstrated through training files, the initial and annual training, and the training course list.

3.1 Training Records

A training file is created for the employee that includes a job description, a summary of all training, and a summary of required training. Alternatively, the required training for all employees/job descriptions can be summarized in a single document and kept with the training records. Also included in the training file are records that document that the required training has been completed. An example of one type of training record that may be used is included in Appendix I. In addition, there are different types of computer programs used to track and document training. As an alternative to maintaining a paper training file, computer programs may be used to track and document personnel training.

3.2 Initial and Annual Training

RCRA training may begin before the employee works in a hazardous waste management unit but must be completed within six (6) months of their assignment to work in a hazardous waste management unit. Employees do not work in an unsupervised position in the hazardous waste management unit until the required training is completed. Each employee will participate in a review of his or her initial training at least annually (once per calendar year).

3.3 Training Course List

A list of training courses currently taught on-site is included in Appendix I. Courses are typically all or part of the basic concepts described in Section 2 of this document. Procedures are typically included as part of a course. For example, procedures related to drum handling would be included in the container management training course. The course list is subject to change by the Permittee as procedures and facility capabilities change. The training times associated with each course are tailored to meet the training needs of each employee. Understanding of the topics covered may be demonstrated through written, oral, or practical exams. Written exams, when used, will be included as part of the training record.

Appendix 1

EXAMPLE OF COURSE DESCRIPTIONS AND FREQUENCY

EXAMPLE OF CLASS ATTENDANCE RECORD

NOTE: The course list and attendance record are subject to change by the Permittee as facility conditions and operations warrant.

CHESI LONE MOUNTAIN FACILITY
Training Session List

Course	Descr	Short Desc	Status
AD1001	Affirmative Action Plan	AD1001	A
AD1002	FMLA	AD1002	A
AD1003	I-9	AD1003	A
AD1004	Personnel Files	AD1004	A
CP0100	CERTIFIED CHEMIST TRAINING	CCT	A
CP0150	Lead Chemist Certification	LCHEMCERT	A
CP0175	Sr. Lead Chemist Certification	SRLDCHEMCE	A
CP0400	WWT Labpack SOP	HS1313	A
CP1000	Lab Pack Training Program	BUS033	A
CP1005	Lab Pack Computer System	SYS095	A
CP1010	CleanPack Worksheet Completion	CHI112A	A
CP1015	Intro to LP Presentation	LPINTRO	A
CP1020	LP Waste Routing & Disposal Fa	LPRD	A
CP1030	LP Disposal Codes and Guidelin	LPDCG	A
CP1035	LP Segregation and Packing Pro	LPSEGPACK	A
CP1040	DEA Controlled Substances Ship	DEASHIPPRO	A
CP1045	Mercury Packaging and Routing	HGPACK	A
CP1050	Organic Peroxide Shipping and	ORGPEROX	A
CP1055	LP Exemptions	LPEXEMPT	A
CP1060	LP Paperwork	LPPaperwo	A
CP1065	PCB's Shipping and Packaging	PCBSHIP	A
CP1070	LP Disposal Restrictions	LPDISRES	A
CP1075	MAAs and SAAs	MAASAAS	A
CP1080	LP Unknown Material Handling	LPUNKNOWN	A
CP1085	CleanPack Change Order	CPCO	A
CP2000	HHW Guidelines	BUS034	A
CP2005	HHW Site Plan	HS1317	A
CP2010	HHW Part-time Training	BUS031	A
CP2015	HHW Supervisor Training	HHWST	A
CP2020	HHW Orientation	HHWORIENT	A
CP3000	DEA CYLINDER RESPONSE 8HR	DEACY8	A
CP3010	DEA AWARENESS TRAINING	DEAWARE	A
CP3020	Battery Packing	BATTPACK	A
CP3030	Explosives Packaging and Shipp	EXPLPACK	A
CS1000	Beacon	beacon	A
CS1010	Profile	profile	A
CS1015	Direct Ship	DSTRDPARTY	A
CS1020	Pricing	pricing	A
CS1025	Order Mgt/Scheduling	OMSCHED	A
CS1030	Off Spec Management	OSMGT	A
CS1035	Unbilled Report	unbilled	A
CS2000	CSR Orientation	CSRO	A
CS3000	Beacon 1 - Create/Edit Company	BEACON1	A
CS3005	Beacon 2 - Searching	Beacon2	A
CS3010	Beacon 3 - Contacts	Beacon3	A
CS3015	Beacon 4 - Messenger/Setting P	Beacon4	A
CS3020	Beacon 5 - Account Reviews	Beacon5	A

CS3025	Beacon 6 - Pipelines	Beacon6	A
CS3030	Beacon 7 - Call Notes	Beacon7	A
CS3035	Beacon 8 - Credit/Collections	Beacon8	A
CS3040	Beacon 9 - Invoiced Orders/Ope	Beacon9	A
CS3045	Beacon 10 - Budget Tab/My Budg	Beacon10	A
CS3050	Beacon 11 - Reports	Beacon11	A
CS3055	Beacon 12 - Task Manager	Beacon12	A
CS3060	Beacon 13 - Company Instructio	Beacon13	A
CS3065	Annual Beacon Recertification	BEACONREC	A
CS3070	Outlook Training	Outlook Tr	A
CS3075	Peoplesoft Expense	PSEXPENSE	A
CS3080	Profile Completion Instruction	PROFILE	A
CS3085	Template Profiles	REMPROFILE	A
CS3090	Win Web Profile Entry	WWPROFILE	A
CS3100	Waste Class Code Selection	WASTECODE	A
CS3105	Pricing Guidelines	PriceGuide	A
CS3110	Pricing Contract Management	PricingCon	A
CS3115	Bulk Quote Management	BulkQuote	A
CS3120	Drum Quote Management	DrumQuote	A
CS3125	CleanPack Quote Management	CPQuote	A
CS3130	Site Service Quote Management	SSQUOTE	A
CS3135	OS Orientation for CS	OSORIENT	A
CS3140	Drum Order Management	DOM	A
CS3145	Bulk Order Management	BOM	A
CS3150	CleanPack Order Management	CPOM	A
CS3155	Site Service Order Management	SSOM	A
CS3160	Container Management Training	CMT	A
CS3165	Purchase Order Management	POM	A
CS3170	Proactive Calling	PROCALL	A
CS3175	Print Paperwork	Print	A
CS3180	Research Receiving and Trackin	RESEARCH	A
CS3185	Open Order Management	Open Order	A
CS3190	Site Service Worksheet Complet	SSWC	A
CS3195	Drum Worksheet Completion	DrumWorks	A
CS3200	Bulk Worksheet Completion	BulkWorks	A
CS3205	Site Service Worksheet RAEP	SSWRAEP	A
CS3210	CleanPack Worksheet RAEP	CPWRAEP	A
CS3215	Drum Worksheet RAEP	DrumWRAEP	A
CS3220	Bulk Worksheet RAEP	BulkWRAEP	A
CS3225	Time Keeping Reconciliation	TIMERECSUB	A
CS3230	Document Scan and Retrieve	DocScanR	A
CS3235	Kiosk Time Entry Procedures	KIOSKTIME	A
CS3240	Dispatch System and Logistics	DSLWORKBEN	A
CS3245	Month End Close	MCLOSE	A
CS3250	Site Service Change Order	SSCO	A
EC1000	Ontario Env. Prot. Regulations	CPL090	A
EC2000	Quebec Hazmat Regulation	CPL095	A
EC2500	Canadian Shipping Hazmat Sampl	CPL120	A
EC3000	Quebec Iso 14001	CPL100	A
EC3500	Quebec ISO 14001 Internal Audi	CPL110	A
EC4000	Canadian Material Profile	CPL115	A

ET1000	Driver Trainer Training	DTT	A
ET1020	Module 1/2: Light Duty Trucks	TRNSO8	A
ET1030	Module 3/4: Rack & Box Trucks	TRNS09	A
ET1031	Module 3/4: OJT Completed	TRN09A	A
ET1040	Module5:Straight Vacuum Truc	TRNS10	A
ET1041	Module 5: OJT Completed	TRM10A	A
ET1050	Module 6: Cusco/Vactor	TRNS11	A
ET1051	Module 6:OJT Completed	TRN11A	A
ET1060	Module 7/8: Str. Rolloff/ Dump	TRNS12	A
ET1061	Module 7/8 OJT Completed	TRN12A	A
ET1090	Mod 9/10: Van/Fltbd/Dropdeck	TRNS13	A
ET1091	Module 9/10 OJT Completed	TRN13A	A
ET1100	Mod 11/12:Tractor Rolloff/Dump	TRNS14	A
ET1101	Module 11/12: OJT Completed	TRN14A	A
ET1110	Module 13 Vacuum Trailer Trans	TRNS15	A
ET1111	Module 13:OJT Completed	TRN15A	A
ET1130	Module 14: Dump Trailer (sadt)	TRNS18	A
ET1131	Module 14: Dump OJT Completed	TRN18A	A
ET1500	Cargo Tank Training	TRNS19	A
ET1501	Cargo Tank Tr-the-Tr	COMM15	A
ET2000	DOT Regs for Drivers/ NDT	TRANSI	A
ET2001	DOT Refresher-Drivers	TRANSC	A
ET2002	DOT Regulation Haz Mat Empl.	CPL053	A
ET2004	Fed Motor/CH Policies and Proc	FMCSPP	A
ET2010	Hours of Service	CPL054	A
ET2020	IATA Dangerous Goods Shipping	HS0045	A
ET2021	IATA Radiactive EQ	IATAREQ	A
ET2022	DOT Rad Module	EXCQTY	A
ET2026	Bulk Liquid Transfer Operation	TEC229	A
ET2030	Sampling Hazardous Materials	CPL060	A
ET2041	Module 1: Shipping Descr (Haz)	TRNS02	A
ET2042	Module 2: Labels or Marking	TRNS03	A
ET2043	Module 3: Placarding	TRNS04	A
ET2044	Module 4: Packaging	TRNS05	A
ET2045	Module 5: Segregation	TRNS06	A
ET2046	Module 6: Manifesting	TRNS07	A
ET2047	Defensive Driving (Internal)	HS5206	A
ET2048	NSC Defensive Driving	TRN16A	A
ET2049	Defensive Driving Tr-the-Tr	COMM08	A
ET2052	Operation Air Brakes	TRNS17	A
ET3000	Hazardous Waste Management	CPL034	A
ET3001	Environmental Awareness	HS1314	A
ET3010	Haz Waste Management Refresh	HS001N	A
ET3015	Advanced Haz Waste Management	HS0046	A
ET3020	Large Quanity Generator	BUS071	A
ET3025	Manifesting and Land Ban	CPL002	A
ET3030	TSD Facility Operations	CPL011	A
ET3035	Waste Codes	CPL016	A
ET3040	Radioactive Hazmat Transport	ET3040	A
ET3045	Import & Export of Haz Waste	CPL075	A
ET3050	Annual RCRA Training	CPL038	A

ET3500	RCRA-Subpart CC	ENV100	A
ET3510	RCRA for Generators	RCRAGEN	A
ET4000	Driver Vehicle Inspection Rept	ET4000	A
ET4005	Roadside Insp. /Vehicle Exams	ET4005	A
ET4010	Guidelines - Company Equipment	ET4010	A
ET4015	Release/Incident Reporting	ET4015	A
ET4020	Trans. Security Awareness	ET4020	A
ET4025	IMDG Transportation	ET4025	A
ET4030	Transportation Security Train	TSECT	A
ET4050	Rail Tank Car Inspection	TRNS16	A
ET4051	Pre-Post Trip Inspection	TRN17A	A
ET4055	Rail Car Transfer	Rail Car T	A
ET4060	Load Securement	TRN120	A
ET5015	Toxic Substance Control Act	TSCA	A
ET5016	PCB	HS015K	A
ET5017	Management of Used Oil	CPL070	A
ET7030	In-House Codes and Paperwork	HS006K	A
EX2002	External Hazmat Employee	ET2002	A
EX2020	IATA DGR EXTERNAL	IATAEXT	A
EX4050	Rail Tank Car Inspection	ET4050	A
HC1000	Canadian CPR (1 Year Renewal)	HCS050	A
HC1010	Osha Module January-WHMIS	HSC041	A
HC1020	Canadian First Aid	HSC051	A
HC1030	Canad Red Cross/First Aid CPR	HSC053	A
HC1040	Canada RedCross Stand First Ai	hsc054	A
HC1050	BC Occupational First Aid 1	HSC055	A
HC1060	BC Occupational First Aid 11	HSC056	A
HC1070	BC Occupational First Aid 111	HSC057	A
HC1080	CPR & First Aid	HSEXT1	A
HS0010	H&S Admin Personnel	HS5201	A
HS001B	OSHA 40 Hour	H&S 1B	A
HS1025	Substance Abuse Supervisory TR	HS0044	A
HS1030	Substance Abuse DOT - Employee	HS0047	A
HS1041	01 of 08 - HAZCOM	HS1041	A
HS1042	02 of 08 - Medical/Bloodborne	HS1042	A
HS1043	03 of 08 - Resp. Protection	HS1043	A
HS1044	04 of 08 - Conf. Space/Heat st	HS1044	A
HS1045	05 of 08 - PPE/Hearing	HS1045	A
HS1046	06 of 08 - Decontamination	HS1046	A
HS1047	07 of 08 -Emergency Response	HS1047	A
HS1048	08 of 08 - Drum & Material Han	HS1048	A
HS1049	09 - Cold/Fire	HS1049	A
HS1050	10 - Fall Protection	HS1050	A
HS1051	11 - Back Safety	HS1051	A
HS1052	12 - LOTO/Electrical	HS1052	A
HS2000	OSHA 40 Hour Hazwoper	HS001B	A
HS2010	Equivalency Exam	HS1306	A
HS2050	Hazwoper 16 Conversion Train	HS5207	A
HS2100	OSHA 24 Hour Hazwoper	HS0024	A
HS2200	Hazwoper Annual Refresher	HS001E	A
HS2300	Emergency Resp Hazmat 24 Test	HS5208	A

HS2350	Emergency Resp Hazmat Spec 24	HS5209	A
HS2360	Emergency Response Refresher	HS015T	A
HS2500	Osha Construction Safety Train	OCSHT	A
HS2600	General Industry Training	HS5200	A
HS2700	Hazwoper Man/Sup Training	HS1319	A
HS4005	Acetylene Torching/Cutting	HS0040	A
HS4010	Bonding & Grounding	HS0600	A
HS4015	Winter Driving	HS1316	A
HS4020	Powered Industrial Truck	HS015A	A
HS4025	Powered Indust Truck Refresher	HS5204	A
HS4030	Plasma Torching/Cutting	HS0041	A
HS4035	Reactives/Explosives	HS0042	A
HS4045	Boat Safety	HS015L	A
HS4046	Certified Vessel Operator Exam	HS015M	A
HS4047	Certified Vessel Operator Prac	HS015N	A
HS4050	Railroad Safety	HS024R	A
HS4055	Lockout/Tagout Affected	HS0300	A
HS4056	Loto Affected Exam	HS4056	A
HS4060	Aerial Lift Training	HS0039	A
HS4061	Aerial Lift Exam	HS4061	A
HS4065	Elevated Work Platform	HS5210	A
HS4066	Elevated Work Exam	HS6101	A
HS4075	HIS High Pressure Water Jet	HS5502	A
HS4076	HIS HPWJ OJT	HS5503	A
HS4080	Loto Authorized Training	HS4080	A
HS4081	LOTO Authorized Exam	HS6081	A
HS4090	Hot Work Training	HS4090	A
HS4095	Hot Work Authorized Training	HS4095	A
HS4096	Hot Work Authorized Exam	HS4096	A
HS4100	Scaffolding Competent Person	HS4100	A
HS5000	Safe Proc. Material Handling	HS5202	A
HS5005	Anthrax Hazard & Safe Work	HSANRX	A
HS5010	Cadmium Safety	HS14ZZ	A
HS5020	Asbestos Safety	HS0151	A
HS5025	Acrylonitrile Safety	HS015D	A
HS5030	Methylene Chloride	HS015B	A
HS5040	Formaldehyde Safety	HS014Y	A
HS5045	Arsenic Safety	HS014X	A
HS5050	Benzene Safety	HS014W	A
HS5055	Lead Safety	HS014U	A
HS5060	Cyanide Handling	HS0043	A
HS5065	Vinyl Chloride Safety	HS014Z	A
HS5070	HF Handling	HS5070	A
HS5075	Radiation Awareness	HS002I	A
HS5080	Reg Substances Part 1	HS0100	A
HS5090	Regulated Substances Part 2	HS0200	A
HS5095	Hydrogen Sulfide Awareness	HSAware	A
HS5205	Chemical Hygiene Plan Training	Chem Hygie	A
HS6000	CPR	HS0003	A
HS6005	First Aid	HS0008	A
HS6010	Cold Stress	HS1301	A

HS6015	Heat Stress	HS014B	A
HS6020	Fire Safety	HS1303	A
HS6025	Bloodborne Pathogen	HS1305	A
HS6029	Medical Surveillance	HS1304	A
HS6030	Hazardous Communication	HS0700	A
HS6035	Toxicology	HS014L	A
HS6040	Personal Protection Equiptment	HS014C	A
HS6045	Hearing Conservation & Safety	HS014V	A
HS6050	Decontamination	HS1000	A
HS6060	Respiratory Protection	HS0800	A
HS6065	Scba/ Air Use	HS1312	A
HS6070	Qualitative Fit Test	HS5400	A
HS6071	Quanititative Fit Test	HS5401	A
HS6080	Competent Person	HS0020	A
HS6085	Electrical Safety	HS0035	A
HS6090	Excavation & Trenching Compete	HS005X	A
HS6091	Excavation Safety	HS0400	A
HS6095	Air Monitoring	HS1100	A
HS6100	Fall Protection	HS1315	A
HS6105	Drum Handling	HS1302	A
HS6116	Back Safety	HSBACK	A
HS6120	Driver Slips, Trips and Falls	DVRSTF	A
HS6122	Fire Extinguisher Training	HS520X	A
HS6130	Accident Investigation	HS5203	A
HS6135	E.R. Procedures	HS015Q	A
HS6140	Incident Command System	HS1309	A
HS6500	CSE Superviser	HS5101	A
HS6600	Confined Space Rescue	HS1500	A
HS6700	CSE Entrant/Attendant	HS015O	A
HS6900	Underground Vault	HS6900	A
HS7010	Process Safety Mgmt Ldr Course	HS1308	A
HS7012	Process Safety MGT Initial	PSMinitial	A
HS7015	Process Safety Mgt Refresher	HS1318	A
HS7020	Loss Prevention & Control Sup.	LPCS	A
HS7021	Loss Control Introduction	LCI	A
HS7025	Loss Prevention & Control Emp	LPCE	A
HS7026	Employee Task Assessment - LPC	LPCETA	A
HS7027	Job Hazard Analysis - LPC	LPCJHA	A
HS7028	Behavioral Observations - LPC	LPCBO	A
HS7029	Loss Control	LPC	A
HS7050	Umknowns Material Training	UMT	A
HS7060	Reactive Material Foreman	ENV201	A
HS7070	Reactives Material Technician	ENV200	A
HS7075	High Hazard Awareness	HiHazAware	A
HS7080	Cylinder Awareness - 8 hour	CA8	A
HS9000	Accident Reporting	ACCREP	A
HS9100	VPP Introduction	VPPINTRO	A
HS9105	VPP Management Commitment & Em	VPPMGCOM	A
HS9110	VPP Worksite Analysis	VPPWSA	A
HS9115	VPP Hazard Prevention and Cont	VPPHAZCON	A
HS9120	VPP Safety and Health Training	VPPHSTRN	A

HX2000	Outside 40 Hour	HS40EX	A
HX2100	Outside 24 Hour	HS024X	A
HX2200	Outside 8 Hr Hazwoper	HS001X	A
HX6000	Outside CPR	HS003X	A
HX6005	Outside First Aid	HS008X	A
HX6090	Outside Comp Per Excav & Trnch	HS05EX	A
MT1000	Quality Service Skills	BUS039	A
MT1001	Harassment & Discrimination	H&D	A
MT1002	Union Aviodance	UA	A
MT1003	Basic Communications	BasicCom	A
MT1004	Delegation	Deligation	A
MT1005	Company Standards and Values	BUS055	A
MT1010	Presentation Skills	COMM05	A
MT1015	Trainer Certification Program	MT1015	A
MT1020	Remedial Construction Selling	CPL043	A
MT1035	Managing Change	LEAD11	A
MT1040	Interviewing Skills	MGMT02	A
MT1045	Effective Performance Appraisa	MGMT03	A
MT1050	Total Quality Management	MGMT04	A
MT1055	General Manager Orientation	MGMT07	A
MT1060	Supervisor Mgmt. Skills	MGMT08	A
MT1065	Managing Effective Meetings	ORPLN1	A
MT1070	Creative Problem Solving	PROB02	A
MT1075	TTS- Intro & Dispatching	SYS400	A
MT1080	TTS-Advanced Operations	SYS04A	A
MT1085	Common Work Order-Introducti	SYS006	A
MT1090	Common Work Order-GWMPS View	SYS013	A
MT1095	Customer Prospect System	SYS005	A
MT1100	Professional Selling Skills	TEC185	A
MT1105	Technical Sales Training	TEC186	A
MT1110	Profile Completion	TECH21	A
MT1115	Client Fact Sheet	TECH41	A
MT1230	PeopleSoft Training Module	SYS700	A
MT1240	20/20 - Macros	SYS26A	A
MT1400	New Employee Orientation	ENV300	A
MT1450	Harassment/Discrimination	MGMT10	A
MT1460	Edit Review	EDITR	A
MT1465	P&L Management	PLMGT	A
MT1470	PeopleSoft AP PO GL	PSAPPOGL	A
MT3001	Leadership	Lead	A
SA1000	KIDS Jump Start Training	KIDS	A
SA1005	Counselor Training (CSP)	CSP	A
SA1010	Counselor Reinforcement	CounselorR	A
SA1015	Coaching	Coaching	A
SA1020	Signature Service	SigService	A
SA1025	Customer Service Tools	TOOLS	A
SA1030	Legal Contract Review Submit	LEGALREVIE	A
SD0100	Customer Service	SSVCS100	A
SD0300	Intro. to Substance Abuse	SSVCS0300	A
SS0200	Double Diaphragm Pump	PUMPDD	A
SS1000	MINE SAFETY TRAINING	MINE	A

SS1010	CSX ER TRAINING	CSXER	A
SS1030	Fall Protection Chicago WWT	HS5501	A
SS1040	Safety Standards Review/Exam	SSREV	A
SS1100	Fixed Fire Suppression systems	FFIRESUP	A
SS1200	ME State Univeral Regs.	MEUNIV	A
SS1210	CA Traffic Safety Training	FLAGGER	A
SS1220	CA DTSC MANIFEST TRAINING	DTSEM	A
SS2000	RCRA Part B Permit	ENV301	A
SS2025	Contigency Plan	HS0500	A
SS2030	TSCA Permit Tralning	TSCA Permi	A
SS2035	SPCC Training	SPCC Train	A
SS2040	Inspection Plan Training	IPT	A
SS3000	Incinerator Operations	TECH16	A
SS4000	Tank Cleanout Policy	Version 2	A
WCM001	Are You Really Listening?	RULISTENIN	A
WCM002	Interpersonal Communication	INTERPCOMM	A
WCM003	The Effective Business Write	BIZWRITE	A
WHR001	Sexual Harassment Prevention	SHPMGR	A
WHR002	Drug-Free Workplace: Employee	DFWEMP	A
WHR003	Drug-Free Workplace: Managers	DFWMGR	A
WHR004	Prev Employment Discrimination	PED	A
WHR005	Understanding the EEO Law	EEO	A
WHR006	Valuing Diversity	DIVERSITY	A
WMT001	Business Ethics for Managers	BIZETHICMG	A
WMT002	How to Hire the Right People	RIGHTHIRE	A
WMT003	Management Basics	MGTBASICS	A
WPD001	Strategies for Time Management	TIMEMGT	A
WPD002	More Effective Meetings Guide	EFFMEET	A

2.10

Closure Plan

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Appendix 1

1.0 Introduction

The closure and post-closure plans contained herein address the entire Lone Mountain Facility. Upon ODEQ approval, these plans will supersede the existing plans in the permits covering current operations at the facility. Should any changes in operating plans or facility design[1] occur, the Lone Mountain Facility will request the appropriate permit modifications as requited by 40 CFR 264.112(b).

The Lone Mountain Facility is a RCRA-permitted treatment, storage, and disposal facility located in northwest Major County, Oklahoma. Leased and operated by Clean Harbors Lone Mountain, LLC (referred to hereafter as the Lone Mountain Facility). The facility operates under EPA (EPA I.D. No. OKD065438376) and State of Oklahoma authority.

A detailed description of the facility is contained in the General Facility Description of the permit application. The Ground Water Monitoring Program of the permit application describes the geology and hydrogeology of the area.

This plan is submitted based on a "total closure" scenario which is selected to develop a worst-case closure basis. At the time of "final closure", portions of the facility may have future or on-going uses (e.g., laboratory, container management, stabilization, storage, etc.) and those elements of the facility may remain open or unclosed.

1.1 Landfill Cells

Cells 1 through 14 and the Drum Cell are covered by Post - Closure Permit No. OKD065438376PC, and readers interested in closure/post-closure of these cells should refer to that permit for details. Cell 15 subcells 1 through 8 are also in post – closure status.

1.2 Wastewater Treatment System

The Wastewater Treatment System is designed with a theoretical capacity to process 130,000 gallons per day of water soluble liquid hazardous waste. This waste includes contaminated stormwater and leachate collected from disposal cells at the facility. Incoming waste can be unloaded into the caustic or acid storage tanks prior to pretreatment. The waste will be relatively low in suspended solids with a pH of approximately eleven (11) after pretreatment, if necessary. The pretreated waste is subsequently stored in evaporator feed tanks along with wastes not requiring pretreatment. A detailed discussion of the Wastewater Treatment System is found in the Wastewater Treatment System Procedures in the permit application.

[1] This plan covers the permitted portions of the facility. Other changes may occur which are not RCRA permitted activities (e.g. storage and treatment under the provisions of 40 CFR Section 262.34) and they are not covered under the provisions of 40 CFR Part 264 Subpart G (Closure and Post-Closure).

1.3 Treatment or Storage Tanks

The only other existing tanks[2] are two (2) tanks utilized in the stabilization process. The two (2) stabilization tanks are located to the north of Cell 1 and west of Cell 7. They are constructed of carbon steel and are secondarily contained by external tanks. Two (2) waste fuel tanks were once located at the final treatment area of the wastewater treatment system. These tanks were in waste fuel storage service and contained within a coated concrete secondary containment system. The tanks may be replaced with new tanks in the future.

1.4 Drum Dock

Container storage is conducted at the Drum Dock. This building is utilized for receiving, sampling, segregating, storing, and treating containerized wastes in sizes typically ranging from one (1) pint upward. A detailed description of the Drum Dock is provided in the Container Storage Management Practices and the Drum Dock Secondary Containment System and Drawings of the permit application.

1.5 Container Management Building

Container storage is also conducted at the Container Management Building. This building is utilized for receiving, sampling, segregating, storing, and treating containerized wastes in sizes typically ranging from one (1) pint upwards. A detailed description of the Container Management Building is provided in the Container Storage Management Practices and the Container Management Building Secondary Containment System and Drawings of the permit application.

1.6 Future Units

A Class 3 Permit modification was approved by ODEQ to increase the waste disposal capacity of Cell 15 from 5,264,000 cy to 8,065,500 cubic yards. This cell will be constructed with a triple liner/leachate collection and detection system. Cell 15 will consist, in ascending order, of a three (3) foot clay compacted clay liner and a bottom sixty (60) mil thick HDPE textured geomembrane; a bottom double sided geocomposite leak detection drainage layer a middle textured geomembrane HDPE liner, which is sixty (60) mil thick; a Geosynthetic Clay Liner (GCL); ; an upper textured geomembrane HDPE liner, which is sixty (60) mil thick; an upper double sided geocomposite leachate collection drainage layer and 2 ft. thick protective cover. A detailed description of Cell 15 is contained in the in the Engineering Design Report to accompany a Class 3 Permit Modification of Landfill Cell 15 dated June 2014 and approved February 25th 2015.

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[2] Other than those tanks operating under the conditions of 40 CFR Section 262.34.

The following new tank systems may be constructed and operated:

Tank System	Function
Waste Fuel Tank Farm	Storage and blending of waste fuels.
Container Management Surge Tanks	Storage of liquid removed from containers in the Container Management Building
Solids Handling Building Tanks	Storage of bulk solids prior to being placed in a landfill or treated

Storage of bulk solid wastes, shredding of containers, and sludge stabilization will be accomplished in the Solids Handling Building prior to landfilling of the wastes. A description of the Solids Handling Building is provided in Solid Handling Building Tank Procedures of the permit application.

2.0 Closure Performance Standard

The Lone Mountain Facility will be closed in a manner that minimizes the need for further maintenance; controls, minimizes, or eliminates, to the extent necessary to protect human health and environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface water or to the atmosphere. Closure operations and post-closure care have been an integral part of the design and operation of the facility. Facility operations have been designed to meet existing standards and in most cases exceed the minimum requirements.

The current long-range facility operations schedule has provisions for the orderly closing of specific disposal units over the next decade. The Lone Mountain Facility will monitor these units prior to final facility closure, which is estimated to occur in 2040. Long term performance histories will thus be established for many of the units during this time. The experience gained from such will be applied to the final closure plans. Areas in which the Lone Mountain Facility expects to gain valuable knowledge include:

- surface contouring for successful erosion control;
- cap and cover integrity under prevailing climatic conditions; and
- leachate system performance.

This experience will be combined with the best engineering judgement to produce facility operations and closure plans, which will minimize the need for post closure care plus protect human health and the environment.

3.0 Partial Closure and Final Closure Activities

The closure of the entire facility requires that an orderly sequence of steps be followed. The Lone Mountain Facility will implement steps 1 through 14 in order to accomplish final closure of the facility. Steps 1 through 3, and the steps relevant to the particular unit being closed, will be implemented to accomplish partial closure of a hazardous waste management unit. Steps 1 through 14 follow:

1. A "Notice of Intent to Closure" will be sent to the Oklahoma Department of Environmental Quality (ODEQ) at least 60 days prior to the date partial or final closure is anticipated to begin. This notice will be accompanied by a copy of the closure plan, if a modification is being requested, and will indicate the date closure activities are expected to commence. Should the Lone Mountain Facility find it necessary to close a portion of the facility prior to final closure, a "Notice of Intent to Close" that portion of the facility will be filed[3] as previously indicated. The notice will specify the portion of the facility to be closed arid the anticipated closure date. Applicable closure plans will accompany the notice should the anticipated closure activities vary from this plan.

2. If this closure has not been previously approved, this plan or, if submitted, the more unit specific plan, will not be implemented until approval by ODEQ or other authorized agencies has been received.

3. Within ninety (90) days after receiving the final volume of hazardous wastes or within 90 days of approval, the Lone Mountain Facility must treat, remove from the unit, or dispose of all hazardous wastes associated with that unit in accordance with the approved closure plan. The estimated time requirement, assuming no force majeure delays, for individual cell closure after the final receipt of waste is approximately thirteen and one-half (13½) months. The Lone Mountain Facility has previously requested and been granted a time extension. The estimated closure time for the Wastewater Treatment System is 210 days, assuming no force majeure delays.

4. The container storage areas and associated RCRA tank systems shall be decontaminated and salvaged, left as constructed, or they may be managed as waste according to the procedures specified in the Waste Analysis Plan. All RCRA permitted tanks shall either be decontaminated and salvaged, left in place, or managed according to the conditions of the Waste Analysis Plan.

5. The up-gradient and internal storm water diversion ditches, diversion dikes, channels, detention pond, culverts, etc. will be retained throughout closure and post-closure in order to protect the facility from surface water run-on.

[3] During the life of the facility, units and equipment will be dismantled or replaced, but these activities do not constitute facility closure. For example, when tanks (or elements of a tank) require replacement, the tank (or tank elements) may be managed as waste according to the procedures specified in the Waste Analysis Plan. This provision holds true for hoses, pipes, steel, concrete, filters, and any other waste handling equipment so long as the permitted capacity is not intended to be deleted. The same holds true for elements such as sumps or tanks which are converted to secondary containment units (e.g., truck wash bay sump, etc.). In the latter case, the unit is not "closed," but will be subject to final or partial closure standards.

6. Decontamination or disposal will be provided for contaminated soils, structures, and equipment.

7. The landfill cells will be closed and capped to substantially eliminate infiltration of rainwater into the units, to shed precipitation, and to minimize erosion.

8. Contaminated liquids generated by the closure process and compatible aqueous wastes removed from other disposal or storage areas will be managed as waste according to the procedures specified in the Waste Analysis Plan.

9. Additional grading and excavation will be performed, as required, to manage run-off from the closed disposal areas.

10. All necessary ground-water monitoring wells will be preserved and maintained throughout closure and post-closure (as specified in the Post-Closure Permit). The ground-water monitoring program utilized during the active life of the facility will continue during closure and post-closure (as specified in the Post-Closure Permit), with the exception that the number of wells actively monitored will be reduced over time.

11. The leachate withdrawal pipes (risers) from landfill cell leachate collection systems will be protected and maintained during closure and post-closure.

12. The fence, gates, and warning signs will be maintained in accordance with the provisions of the Post-Closure Permit.

13. Within 60 days of completion of partial or final closure, the Lone Mountain Facility will submit the certification of closure to the ODEQ. This certification, by a registered professional engineer, will attest that the unit or units have been closed in accordance with the specifications of this closure plan.

14. No later than the submission of the certification of closure, the Lone Mountain Facility will submit to the ODEQ and to the Major County Land Office, a survey plat prepared by a professional land surveyor indicating the location and dimensions of landfill cells and other permanent structures with respect to permanently surveyed benchmarks. The plat will include an attachment, which states the Lone Mountain Facility's obligation to prevent disturbance of the facility. A record of the type, location, and quantity of wastes disposed within each cell will be submitted to the agencies. The Lone Mountain Facility will record a notation on the property deed indicating that the facility has been used to dispose of hazardous wastes, and that land usage is restricted to activities that will not disturb the wastes.

4.0 Maximum Extent of Operations and Maximum Waste Inventory

Table 1 indicates the maximum inventory of hazardous wastes that could be on-site at Lone Mountain. The maximum inventory of wastes in storage would occur if all units were at maximum capacity, yet not closed. The maximum amount of waste requiring treatment would be the capacity of the storage tanks and containers.

Table 1
Maximum Inventory of Wastes That Could Be On-Site at Lone Mountain Facility

Unit	Design Capacity	Status (As of May 2020)
Drum Cell	---	Post-Closure
Cell 1	---	Post-Closure
Cell 2	---	Post-Closure
Cell 3	---	Post-Closure
Cell 4	---	Post-Closure
Cell 5	---	Post-Closure
Cell 6	---	Post-Closure
Cell 7	---	Post-Closure
Cell 8	---	Post-Closure
Cell 9	---	Post-Closure
Cell 10	---	Post-Closure
Cell 11	---	Post-Closure
Cell 12	---	Post-Closure
Cell 13	---	Post-Closure
Cell 14	---	Post-Closure
Cell 15	4,999 A	Active
Drum Dock	24,365 G	Active
Waste Fuel Tanks (D1 & D2)	17,098 G	Inactive/Out-of-Service
Container Management Building	182,930 G	Active
Solids Handling Tanks	682,176 G	Pending
Stabilization Tanks	35,904 G	Active
Waste Fuel Tank Farm	405,550 G	Pending
Container Mgmt. Surge Tanks	25,600 G	Pending
Wastewater Treatment Tanks	2,286,659 G 1,663,481 G	Active (18 Tanks) Pending (42 Tanks)
Miscellaneous Container Storage Areas	18,160 G	Pending/Active
A = Acre-feet	G = Gallons	

Table 2 identifies the maximum extent of operations that will be open during the active life of the facility. As units are closed, the maximum extent of operations will decrease.

Table 2
Maximum Extent of Operations That Will Be Open During the Active Life of the Facility

Unit	Design Capacity
Cell 15	1,225 A
Drum Dock	24,365 G

Table 2 Maximum Extent of Operations That Will Be Open During the Active Life of the Facility	
Unit	Design Capacity
Waste Fuel Tanks (D1 & D2)	17,098 G
Container Management Building	182,930 G
Solids Handling Tanks	682,176 G
Stabilization Tanks	35,904 G
Waste Fuel Tank Farm	405,550 G
Container Mgmt. Surge Tanks	25,600 G
Wastewater Treatment Tanks	3,950,140 G
A = Acre-feet	G = Gallons

5.0 Schedule for Closure

For the purpose of this plan, closure of operations at the Lone Mountain Facility is estimated to occur in 2040. Existing units and proposed future expansion units are tentatively scheduled to close as shown in Table 3[1].

Table 3 Closure Schedule for Lone Mountain Facility	
Existing Units Subject to Closure	Estimated Year of Closure
Cell 15	2040
Drum Dock	2040
Waste Fuel Tanks (D1 & D2)	2040
Stabilization Tanks	2040
Container Management Building	2040
Wastewater Treatment System	2040
Proposed Units or Future Units	Estimated Year of Closure
Container Mgmt. Surge Tanks	2040
Solids Handling Building Tanks	2040
Waste Fuel Tank Farm	2040

[1] Earlier or later closure may occur on different cells or units. This schedule is given for the basis of estimating closure costs at their maximum extent. Earlier or later closures or projections of earlier or later closures will not necessitate modification of this section or the closure plan or cost estimates.

6.0 Time Allowed for Closure

The following tables that estimate Closure Time are all based on calculations. Appendix 1 details a sample calculation to arrive at the time estimates. At the closure of the entire Lone Mountain Facility, there is a possibility additional cells will be in operation. These additional cells will be addressed in future permit applications. Table 4 details an estimate of the status of the landfill cells during the next five (5) years. The predicted status of the unit is indicated for every March and September.

Table 4 ESTIMATED TIME REQUIREMENTS* FOR CLOSURE OF CELL 15 AND WASTEWATER TREATMENT SYSTEM (PARTIAL FACILITY CLOSURE, ASSUMES NO FORCE MAJOR DELAYS)	
LANDFILL	MONTHS
Mound Preparation	3.0
Clay Cap Liner Construction or GCL Installation	3.0
Final Cap Construction	3.0
Cover and Drainage Controls	2.5
Certification	2.0
TOTAL	13.5
WASTEWATER TREATMENT SYSTEM	DAYS
Treatment and Disposal of Waste	60
Clean Out and Decontaminate Truck Wash	10
Dismantle/Dispose of Tank Systems	40
Clean Pre-Treatment Buildings	20
Clean Final Treatment Buildings	20
Certification	60
TOTAL	210

7.0 Closure of the Entire Facility

At closure of the entire facility, estimated to occur in 2040, one cell is expected to be operational. The tank systems, Drum Dock, Container Management Building, Miscellaneous Container Storage Areas, Wastewater Treatment System, and Solids Handling Building tanks should also be operational. Table 5 details the anticipated closure activities of the entire facility.

Table 5 ESTIMATED COURSE OF EVENTS AT CLOSURE OF THE ENTIRE FACILITY		
DATE	MONTHS ELAPSED	EVENT
08/31/2039	-2	Notification to ODEQ.
10/30/2039	0	Final receipt of wastes. Begin workforce mobilization
10/30/2039	0	Commence removal and treatment of liquids in containers and tanks.
12/31/2039	2	Complete disposal or salvaging of tanks not associated with Wastewater Treatment System. Decontamination of container management areas (Drum Dock and Container Management Building), truck washout pad, or stabilization.
1/31/2040	3	Complete treatment of liquid in tanks. Commence removal, stabilization, and disposal of sludge and solids

Table 5
ESTIMATED COURSE OF EVENTS AT CLOSURE OF THE ENTIRE FACILITY

DATE	MONTHS ELAPSED	EVENT
02/28/2040	4	Complete removal, stabilization, and disposal of sludge and solids in the Solids Handling Building and Wastewater Treatment System; decontamination of Solids Handling Building.
03/31/2040	5	Completion of waste mound in landfill cell.
03/31/2040	5	Decontamination of Wastewater Treatment System piping, equipment, and building.
07/30/2040	9	Complete placement and compaction of clay cap and cap liner.
12/31/2040	14	Final drainage completed; closure completed, and certification made for all units.

8.0 Closure and Post-Closure Plan Modifications

Copies of the closure and post closure plan are maintained at the Lone Mountain Facility and the Oklahoma Department of Environmental Quality. When facility operational changes dictate a modification to this plan, the Lone Mountain Facility will submit a request for permit modification to make the necessary changes to the plan. This revised copy will be submitted to ODEQ.

9.0 Extensions for Closure Time

As detailed in Table 6, the estimated time requirement in months for closure of an individual cell, assuming no force majeure delays, is approximately thirteen arid one-half (13½) months. Closure of the Wastewater Treatment System will require more than 180 days to complete and is estimated to take 210 days to properly close the unit: The Lone Mountain Facility is requesting approval of these extended closure times as allowed by 264.113(b(1)(i) and approval of this plan shall constitute such approval.

10.0 Inventory Disposal, Removal, or Decontamination

The following steps will be taken to decontaminate various components of the facility at the time of final facility closure:

1. The tractors and trucks will be decontaminated. Decontamination will require the use of steam, heated detergents, or water miscible solvents, whichever is most effective. The rinsate will be managed as a waste according to the procedures specified in the Waste Analysis Plan.

2. Facility personnel will visually inspect the roadways, sampling areas, and unloading areas. Based on visual observations, any surfaces that appear to be contaminated with hazardous wastes will be excavated and managed as a waste according to the procedures specified in the Waste Analysis Plan. A simple sampling strategy will be utilized to determine the cleanliness of the sampling areas and unloading areas.

These areas will be divided into equal area grids, typically 2,500 ft^2 in size. Sampling locations will be taken in the approximate mid-point of the areas. A "total constituent" analysis for metals and constituents identified in Appendix VIII of 40CFR Part 261 will be utilized as a basis for defining "clean closure", realizing that it may not be possible to analyze for all of the Appendix VIII constituents.

Furthermore, the list of constituents will be limited to those waste codes and their constituents managed during the life of the unit. If there is contamination (i.e., the concentration of any contaminants exceeds the background[4] plus three (3) standard deviations), the soil will be removed and managed as waste according to the procedures specified in the Waste Analysis Plan. With ODEQ approval, background analyte levels may be developed using either existing data from the facility or may be developed at the time of closure. The soil removal and sampling will continue until sampling indicates that background levels (plus three (3) standard deviations) have been obtained. Uncontaminated soil will be backfilled into any excavated areas, if necessary.

3. The office and laboratory buildings and the sewage lagoon may remain in place during the closure and post-closure period. Samples of hazardous wastes stored in the laboratory will be managed as waste according to the procedures specified in the Waste Analysis Plan. Discarded laboratory chemicals will be salvaged or managed as waste according to the procedures specified in the Waste Analysis Plan. Throughout the life of the facility, equipment and units may be decommissioned, replaced, and modified. The materials deriving from the activity will be decontaminated and salvaged or managed as waste according to the procedures specified in the Waste Analysis Plan.

11.0 Area/Unit Specific Closure Consideration

11.1 Container Storage Areas Closure

Closure of both the Drum Dock and the Container Management Building is assumed to occur at a point in the life of the Lone Mountain Facility when all regulated disposal units are in full operation and at their maximum waste storage capacity. At closure, the Drum Dock and Container Management Building will be assumed to store their maximum inventories of 24,365 and 182,930 gallons, respectively.

The Drum Dock and the Container Management Building are utilized for receiving, sampling, segregating, storing, and treating containerized wastes. All wastes are transferred to other management units or off-site facilities for storage, treatment, or disposal. The Drum Dock will most likely be closed first, followed by the Container Management Building.

[4] Background levels may be developed using existing data or may be developed at the time of closure.

At closure, it is assumed that the following conditions will exist which will affect the calculation of closure costs:

1. The Drum Dock and Container Management Building will be storing their maximum inventory.

2. Approximately 20% of- all containers will contain solids having no free liquids and can be landfill disposed.

3. Approximately 60% of all containers will contain solids with sludges which can be stabilized and landfilled.

4. Approximately 10% of all containers will contain organic liquids which will be shipped off-site for use as fuel.

5. Approximately 10% of all containers will contain inorganic liquids which can be treated in the Wastewater Treatment System.

The Lone Mountain Facility will close the Drum Dock and the Container Management Building in a manner that will eliminate the need for further maintenance; minimizes or eliminates the post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere, to the extent necessary to protect human health and the environment. The Lone Mountain Facility will comply with the closure and post-closure requirements of 40 CFR 264 Subpart G and Subpart I.

The Drum Dock and Container Management Building were designed and have been operated with provisions for total containment of wastes and prompt clean-up of any spills. All areas outside of the containment systems of the unit are expected to be clean. The Lone Mountain Facility will, nevertheless, thoroughly inspect the areas of the closed units for indications of contamination. If physical evidence (e.g., staining, discoloration, etc.) indicates that contamination may be present, the Lone Mountain Facility will prepare a Soils Sampling Plan for the suspect area(s) to ensure that areas of contamination are investigated and remediated, as necessary. In general, the Plan will involve the taking of soil samples from randomly selected grid points. The soil samples will be analyzed for contamination and areas with indications of contamination will be further investigated. If confirmed, the contamination will be delineated and removed to appropriate levels.

When all containers from the Drum Dock or Container Management Building are removed, any residual liquid in sumps will be managed as waste according to the procedures in the Waste Analysis Plan. Closure of container storage area buildings, floors, equipment, etc. may be accomplished by either the dismantling and disposal of the resulting debris or, alternatively, the cleaning and decontamination of the structure in-situ. If decontamination is chosen, the floors, walls, equipment, etc. of the building will be first scraped, sandblasted, or swept to remove all loose or caked residue. The residue will be stabilized, disposed, or transferred to an off-site facility. The containment area, equipment, etc. will them be washed/rinsed. The wash will be performed with a high-pressure stream of water or steam with suitable detergents or other cleansing agents, as required. This will be followed by rinsing with clean water, as needed. A sample of the rinse will be obtained and analyzed for the parameters listed in Table 6. The Drum Dock and Container Management Building will be considered decontaminated when the analysis of the rinse water meets the criteria in Table 8.

Table 6
DECONTAMINATION PARAMETERS

PARAMETERS	MAXIMUM CONCENTRATION (MG/L)
Arsenic – Total	0.5
Barium – Total	10.0
Cadmium – Total	0.1
Chromium – Total	0.5
Lead – Total	0.5
Mercury – Total	0.02
Selenium – Total	0.1
Silver – Total	0.5
Total Organic Halogens	10.0
Total Organic Carbon	100
Total Cyanide	2.0

Miscellaneous Container Storage Areas, if used, will be closed in a manner similar to that which is described above.

Rinsing will continue until the above criteria are met. The rinsate will be treated as waste according to the procedures specified in the Waste Analysis Plan. If decontamination is not achieved, the buildings, equipment, etc. will be managed as waste according to the procedures specified in the Waste Analysis Plan.
Upon completion of closure, a certification by an independent registered professional engineer attesting that the Drum Dock and/or Container Management Building have been closed in accordance with this closure plan will be included with the submittal to the ODEQ. All applicable quality assurance programs specified in the permit application will be followed during closure.

11.2 Solids Handling Building Closure

The Solids Handling Building does not currently exist but may be constructed in the future. Six (6) solids handling tanks will be located in the Solids Handling Building. Closure of the Solids Handling Building will probably follow closure of the Container Management Building. At closure, all solid wastes from the storage area tanks will be managed as waste according to the procedures specified in the Waste Analysis Plan. Equipment will likely be decontaminated with a double wash/rinse (e.g., steam/water). Rinsing will continue until the criteria specified in Table 8 are met.

The sludge bins and size reduction equipment will have twenty (20) cubic yards of limestone, gypsum, or other material free of hazardous wastes, processed through the equipment in order to aid in the removal of waste residue from equipment surfaces. The material will be managed as waste in accordance with the procedures specified in the Waste Analysis Plan. The floors; walls, or other potentially salvageable equipment will be scraped, sandblasted, brushed, or swept to remove all loose or caked residue prior to the wash process. All solid residue materials and rinsate will be managed as waste in accordance with the procedures specified in the Waste Analysis Plan. The following is a partial list of salvageable equipment which may be decontaminated: front-end bucket loaders, shredder, grizzly, vibrating screens, hand tools, and the sludge and solidification material bins. The conveyor systems will likely be dismantled and landfilled. Any items which are not decontaminated will be dismantled, removed; and managed as waste in accordance with the procedures specified in the Waste Analysis Plan.

Upon completion of closure, the Lone Mountain Facility will submit the closure certification to the ODEQ. All applicable quality assurance programs specified in the permit application will be followed during closure.

11.3 Office and Laboratory Buildings Closure

The office and laboratory building, and the sewage lagoons may remain in place during the closure and post-closure period. Samples of hazardous wastes stored in the laboratory will be disposed of on-site or off-site. Laboratory chemicals will be salvaged or managed in accordance with the procedures specified in the Waste Analysis Plan.

11.4 Tank System Closure

Stabilization Tanks. The existing stabilization tanks are open top tanks constructed of carbon steel. The full secondary containment consists of carbon steel exterior tanks. Concrete loading/unloading areas are adjacent to the tanks. The tanks are utilized to stabilize a variety of wastes prior to landfilling. The waste is stabilized by unloading the waste into the tank, feeding stabilization reagents into the tank, and subsequently mixing the waste and reagents with a track hoe.

The Lone Mountain Facility will close the stabilization tanks in a manner that minimizes the need for further maintenance; and minimizes or eliminates the post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere, to the extent necessary to protect human health and the environment. The Lone Mountain Facility will comply with the closure and post-closure requirements of 40 CFR 264 Subpart G, Subpart H, and Subpart J.

After the stabilized waste is removed and placed in a landfill cell, the tanks will likely be scraped, brushed, or sandblasted, and washed/rinsed until decontaminated. The concrete containment areas and unloading areas will likely be scraped, swept, and decontaminated. Any equipment employed in the closure process will be decontaminated or disposed. The tanks, concrete, equipment, etc. will be washed/rinsed until the criteria specified in Table 8 are met. The decontamination solids and rinsate will be treated as waste according to the procedures specified in the Waste Analysis Plan (WAP). If decontamination is not chosen, all tanks, concrete areas, equipment, etc. will be disposed as waste (debris) in accordance with the procedures specified in the WAP.

A simple sampling strategy will be utilized to determine the cleanliness of the soil adjacent to the system and/or where the concrete containment areas had been. The area will be divided into equal area grids. Sampling locations will be taken in the approximate mid-point of the areas. A "total constituent" analysis for metals and constituents identified in Appendix VIII of 40 CFR Part 261 will be utilized as a basis for defining "clean closure", realizing that it may not be possible to analyze for all of the Appendix VIII constituents: Furthermore, the list of constituents will be limited to those waste codes and their constituents managed during the life of the unit. If there is contamination (i.e., the concentration of any contaminants exceeds the background mean plus three (3) standard deviations), the soil will be removed and managed as waste according to the procedures specified in the Waste Analysis Plan. The soil removal and sampling will continue until sampling indicates that background levels (mean plus three (3) standard deviations) have been obtained. With ODEQ approval, background analyte levels may be developed using either existing data from the facility or data developed at the time of closure.

Uncontaminated soil will be backfilled into any excavated portion of the area, if necessary. Upon completion of closure, the Lone Mountain Facility will submit the closure certification to the ODEQ. All applicable quality assurance programs specified in the permit application will be followed during closure.

D1 and D2 Tanks. Tanks D1 and D2 do not currently exist. The old D1 and D2 tanks were previously located southwest of the Wastewater Treatment System. If constructed in the future, the tanks and pad will likely be decontaminated with a wash. Rinsing will continue until the criteria specified in Table 8 are met or the tanks will be managed as waste according to the procedures specified in the Waste Analysis Plan. The decontamination solids and rinsate will be treated as waste according to the procedures specified in the Waste Analysis Plan.

Upon completion of closure, the Lone Mountain Facility will submit the closure certification to the ODEQ. All applicable quality assurance programs specified in the permit application will be followed during closure.

Wastewater Treatment System Tanks. The Lone Mountain Facility will close the Wastewater Treatment System in a manner that minimizes the need for further maintenance, and controls, minimizes, or eliminates to the extent necessary to protect human health and the environment. Post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere. The Lone Mountain Facility will comply with this closure requirement and plans to meet this performance standard by performing removal of all hazardous wastes and hazardous waste constituents to background levels plus three (3) standard deviations. The tanks, piping, and other ancillary parts of the systems will be handled in one of the following ways:

- Dismantled and/or disposed of as hazardous waste; or

- Decontaminated such that they are no longer considered hazardous waste (after which they can be disposed of in a solid waste landfill, or they may be salvaged for other uses).

- The Lone Mountain Facility intends to close the subject waste management units by removal of the waste and waste constituents so that there will not be any need for post-closure monitoring and maintenance of the unit or its component parts. Upon closure, all tankage, external piping, and waste handling equipment may be removed or decontaminated utilizing the parameters listed in Table 8. The decontaminated tanks, buildings, concrete floors/pads, secondary containment, and other permanent structures may remain in place.

The Wastewater Treatment System is designed and has been operated with provisions for total containment of wastes and prompt clean-up of any spills. All areas outside of the containment system of the unit are expected to be clean. The Lone Mountain Facility will, nevertheless, thoroughly inspect the areas of the closed units for indications of contamination. If physical evidence (e.g., staining, discoloration, etc.) indicates that contamination may be present, the Lone Mountain Facility will prepare a Soils Sampling Plan for the suspect area(s) to ensure that areas of contamination ate mitigated. In general, the Plan will involve the taking of soil samples from randomly selected grid points. The soil samples will be analyzed for contamination and areas with indications of contamination will be further investigated. If confirmed, the contamination will be delineated and removed to appropriate levels.

Closure of the treatment and storage units may proceed either sequentially or simultaneously to completion. The following steps will be· followed, beginning with decontamination and removal:

- Residues will be removed and managed as waste in accordance with the procedures established in the Waste Analysis Plan.

- The hard surfaces such as concrete (slabs, pads, and access areas), steel (tanks and pipes), and equipment (pumps, exchangers, valves, etc.) will be swept, brushed, scraped or sandblasted, as necessary, and then washed with water under high-pressure or steam cleaned. The water from the steam cleaning or high-pressure washing and rinsing will be collected and managed as wastes according to the procedures established in the Waste Analysis Plan (WAP).

Samples of the rinse water will be analyzed for the parameters listed on Table 8, and if the results are lower than the values/levels tabulated, the surface is considered clean; if not, rinsing of the surfaces will be repeated. All items that are not to be reused or salvaged will be disposed in a RCRA facility or decontaminated and disposed in a solid waste landfill.

Future Tank Systems. Design information for future tank systems is as follows:

Table 7
FUTURE TANK SYSTEM DESIGN

Tank System	Quantity	Type	Design Capacity (Gal.)	Dimensions
Waste Fuel Tank Farm	10	A	17,650	12'Dx20'H
Mixing	2	O	105,700	30'Dx20'H
Water	1	A	17,650	12'Dx20'H
Container Management Surge Tanks	4	A	6,400	10'Dx10'H
Solids Handling Building Tanks				
Receiving Bins	3	A	112,200	25'Wx30Lx20'D
Receiving Bins	1	A	233,376	30'Wx52'Lx25'D
Conditioned Sludge Bins	2	A	56,100	20'Wx25'Lx15'D
A – Above Ground O- On Ground				

The future tank systems will be closed in a manner that minimizes the need for further maintenance; and minimizes or eliminates the post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere, to the extent necessary to protect human health and the environment. The Lone Mountain Facility will comply with the closure and post-closure requirements of 40 CFR 264 Subpart G, Subpart H, and Subpart J.

At closure, stabilized materials will be land filled. The tanks will be washed and rinsed, and the concrete containment areas will be decontaminated with at least a high-pressure wash. Rinsing will continue until the criteria specified in Table 8 are met. The concrete base will likely be left intact. Any equipment employed in the closure process will be decontaminated. The decontamination solids and rinsate will be treated as waste according to the procedures specified in the Waste Analysis Plan.

Upon completion of closure of the particular tank system, the Lone Mountain Facility will submit the closure certification to the ODEQ. All applicable quality assurance programs specified in the permit application will be followed during closure.

11.5 Landfill Closure

The following is a description of the general components of the final cover of each of the landfill cells to be put in place at closure. Individual cells may have specific closure requirements as outlined in the applicable permit. The cover installation will be performed using the construction quality assurance document for landfill construction and closure (CQA Plan) most recently approved by ODEQ, to ensure that the final cover will meet the following requirements:

1. Provide long term minimization of migration of liquids through the closed landfill cells;
2. Function with minimum maintenance;
3. Promote drainage and minimize erosion/abrasion of the cover;
4. Have a permeability equal to or less than any bottom liner system or natural subsoils present: and
5. Withstand freeze/thaw cycles.

Drawings and details concerning closure of specific landfill units can be found in the design and engineering reports for each unit, which are incorporated by reference into the facility RCRA/HSWA Permit. Landfill cells will be closed according to the following outline:

1. **Mound Preparation**
   a. addition of solids;
   b. compaction; and
   c. grading.

2. **Cap Construction.**
   a. construction of one (1) foot interim cover clay (bedding clay);
   b. Geosynthetic clay liner (GCL);
   c. installation of a 60 mil thick high-density polyethylene (HDPE) geomembrane;
   d. installation of geocomposite;
   e. 1.5 feet protective cover soil;
   f. construction of 6-inches of topsoil;
   g. Grassy vegetation on 10% cover slope and 6-inch thick riprap or grassy vegetation of 3H:1V cover slopes.

3. **Erosion arid drainage controls**
   a. construction of riprap layer;
   b. construction of diversion embankments; and
   c. application of riprap slope protection.

4. **Instrumentation.**

   The final closure phase will begin upon completion of the mound preparation. The cap will provide for the long term minimize ion of migration of liquids through the closed cells, promote drainage, and minimize erosion. Each of these items are discussed in subsequent paragraphs.

11.5.1 Mound Preparation

Although most waste placement in the mound will occur prior to the onset of the closure period, additional and selective waste placement will occur during the mound preparation stage of closure to assist in shaping the mound. Stabilized waste from the Stabilization Tanks or the Solids Handling Building tanks (when active), contaminated soils, residues from other closure activities, or in-coming waste will be placed to within one (1) foot of the embankment crest in the landfill cells, sloped upward toward the center of the cell, arid compacted. The top of the mound with be free of foreign objects and debris, such as rocks, pipes, and tanks, in order to protect the overlying cap liner. The mound win be shaped and contoured to generally conform to the final grading plan. The mound will rise at a maximum slope of approximately ten (10) percent. The mounding of waste will reduce the subsequent and for additional earth fill material; facilitate grading of the clay cap, and redL1ce possible formation of depressions that would pond rainwater.

The "mound" for Landfill Cell 15 will be constructed differently than for previous cells. Cell 15 will be filled and operated in phases; a phased capping approach will also be implemented in phases I through 9 effectively capping subcell's 1 through 22. Thus, capping of Cell 15 will be progressive during cell operation. As waste is placed in Landfill Cell 15, it can be brought to design grade as the filling progresses. Thus, the "mound" for Cell 15 will be constructed in phases, rather than when the entire cell has reached "level full." The final closure certification will be obtained following capping and closure of the final subcell of Cell 15. Preparation of the mound for a phased cell is otherwise similar to preparation of the mound for any other cell at the Lone Mountain facility.

11.5.2 Cap Construction

There are several options that may be used for the first step of cap construction. Details concerning the selected option will be provided to DEQ for each cell prior to cap construction. In the first option, a nominal two (2) foot thick compacted clay cap, with a maximum hydraulic conductivity of 10^{-7} cm/sec, will be constructed on top of the mounded waste. As a second option, a geosynthetic clay liner (GCL) will be installed over a twelve (12) inch soil bedding layer. The GCL will have a maximum hydraulic conductivity of $5X10^{-9}$ cm/sec.

It is anticipated that the clay, if used, will be taken from the borrow area on or near the facility property. Prior to commencement of closure, representative cote samples of the clay to be used for cap construction will be test d to ensure it meets the specifications in the current CQA Plan.

The first lift of clay over the waste mound will either be placed thicker than the six inch maximum specified in the CQA plan - approximately one (1) foot thick, or will be placed at the specified thickness and compacted with equipment other than a sheepsfoot compactor (e.g., a bulldozer or smooth roller). These modified procedures are necessary to prevent waste from being mixed into the clay cover material. Subsequent lifts will be placed and compacted in accordance with the procedures specified in the CQA plan. Near the edges of the cell, lift thickness may vary, and hand compaction methods may be used, to prevent damage to the HDPE liners. Progress will be at such a rate as to facilitate proper moisture and compaction control. Care will be taken during compaction of each lift to provide a good knitting of the layers.

The compacted clay cap will be graded to conform to the planned final drainage patterns. The cap surface will be shaped to avoid forming any depressions that might pond water.

For cells in which GCL is used in the cap, the two (2) foot clay layer will not be constructed. When GCL is used, the mound preparation will include shaping of the mound surface to avoid forming any depressions that might pond water. Shaping of the mound will include placement of a six (6) inch soil bedding layer. This soil layer will meet the same specifications as the embankment material, except that it will also have a maximum particle size of one inch. This soil layer will be compacted to a density of at least 95% of Standard Proctor (ASTM D-698) or another testing method determined to be equivalent or superior by the CQA Officer, as described in the CQA Plan. GCL placement will progress such that drainage of precipitation run-off from the closure cap and from the adjacent waste material will be away from the GCL. All GCL placed in the cap will have a hydraulic conductivity of $1X10^{-9}$ cm/sec. or less, as determined by manufacturers specifications.

Above the compacted clay liner or GCL, a sixty (60) mil HDPE liner will be installed. If a GCL is utilized, the HDPE cap liner must be placed promptly in order to prevent excessive moisture (precipitation) from corning into contact with the GCL. The HDPE liner thickness in the cap will equal the HDPE liner thickness in the bottom liner system. The cap liner and bottom liner systems of all cells will have approximately equal hydraulic conductivities of less than 10^{-10} cm/sec.

The cap liner will provide for the long-term minimization of liquid migration through the closed cells. All seams will be subjected to stringent quality control testing to ensure the integrity of the cap liner system, as specified by the CQA Plan. All portions of the cap liner, and in particular the seams, will be visually inspected for the presence of tears, punctures, blisters, or incomplete welds. All seams will be tested for soundness using an electrostatic tester, vacuum tester, or similar and/or equivalent process. The cap liner will be seamed to the uppermost HDPE liner of landfill cells, to provide a barrier against infiltration.

A geocomposite with a transmissivity greater than 3×10^{-5} m^2/s will be placed atop the HDPE cap liner to function as a drainage media for water, which infiltrates the surface soil. A geocomposite consists of a drainage net sandwich between two layers of geotextile. Nominally, twenty-four (24) inches of unclassified soil will be used to cover the separation fabric and net. Since water infiltrating into the cover soil layers will drain through the drainage layer, freeze/thaw cycles will not affect the final cover. Based on Figure 12 of "Evaluating Cover Systems for Solid and Hazardous Waste" (SW-867, September, 1982), the average frost penetration is nine (9) inches. The cap system will provide greater than eighteen (18) inches of protection above the two (2) foot clay cap or the GCL.

Since the cover system operates under gravity influence to remove water, no operating components are required. Effective quality control during the cover system installation will minimize future maintenance needs. If inspections indicate that maintenance is required, the cap will be repaired as necessary.

Some of the cells will utilize (or have utilized) underground piping or conduits to transfer leachate from the cell to storage and treatment areas of the facility. This piping generally consists of several smaller pipes within a larger conduit which provides secondary containment. During or after closure, this leachate piping system will be closed by first flushing the leachate pipes with potable water, then removing them for subsequent disposal in a landfill cell; the remaining, larger pipe would be left in place, and then filled with a cement-grout mixture to prevent collapse at some future date. Alternatively, the larger pipe may be removed and landfilled as well.

11.5.3 Erosion and Drainage Controls

Erosion control and drainage structures will be provided to promote drainage and minimize erosion. Riprap will be placed on the cover soil as erosion protection. Some clay balls may be mixed in with the gravel but will not affect the ability of the gravel to serve as erosion protection for the cover soil. A high evaporation/rainfall ratio, in conjunction with the shallow soil profile for storing soil moisture, will result in a deficiency of moisture necessary to sustain plant growth. The outer edge of the embankments will be raised where necessary, to control and divert runoff, which would otherwise cause erosion problems.

The annual soil loss estimate is based on the 1982 EPA publication, "Evaluating Cover Systems for Solid and Hazardous Wastes," SW-867,

$$A = RK(LS)P\text{-} = 1.8 \text{ tons/acre, where:}$$

A =annual soil loss;
R = 150 from Figure 20, SW-867;
K = 0.01 (assumed based on fact that gravel is expected to have lower value than sand with 4% organics);
LS = 1.3 (for 600 ft reach and slope = 5%);
C = 0.9 (assumed that value will be lower than 1.0 since no tillage will occur); and
P = 1.0 (worst case assumption).

Erosion of the exterior slopes of embankments will be prevented by constructing drainage interceptor structures such as culverts.

11.5.4 Instrumentation

Settlement and subsidence due to effects of potential foundation, soil liner, and waste consolidation will be minimal. The foundation bearing capacity exceeds 15,000 psf. Any waste consolidation will primarily occur prior to cap construction. Potential cover subsidence due to later waste consolidation will also be minimal. Compaction of waste with compaction equipment minimizes waste consolidation. The minimal settlement and subsidence will ensure that the final cover does not lose its integrity. Inspections will include the inspection of the cover systems for depressions. Cover maintenance will rectify any cover subsidence.

During the closure period, the Lone Mountain Facility will continue the ground water detection monitoring program detailed in the permit and the Ground Water Monitoring Program of the permit application. After closure, a certification by an independent registered professional engineer attesting that the landfill has been closed in accordance with the closure plan will be submitted to the ODEQ.

Appendix 1

CLOSURE TIME ESTIMATES

The following calculations present the approximate time requirements for the closure of Cell 15. These do not include weekends and time for events such as poor weather conditions, equipment down-time, etc.

Top Dimensions	694-ft x 620-ft
Operating Capacity	575,650 cubic yards

Mound Construction

$$\frac{694' \times 620' \times 4'}{27\ ft^3/yd^3} \times \frac{(1)}{40\ trucks/day \times 18\ yd^3/truck} = 89\ days$$

Cap Construction
Clay or Soil Placement

$$\frac{2\ Scrapers\ (22\ yd^3)}{Scraper} \times \frac{(5\ loads)}{Hr} \times \frac{(8\ hours)}{Day} = \frac{1760\ yd^3}{Day}$$

HDPE Liner placement is approximately 9,000 ft^2/day.
Net and fabric placement is approximately 43,000 ft^2/day.

Clay Liner

$$\frac{694\ ft \times 620\ ft \times 2\ ft}{27\ yd^3 \times 1760\ yd^3/day} = 18\ days$$

Clay compaction, finishing, etc. = 54 days

HDPE Liner

$$\frac{694\ ft \times 640\ ft}{9{,}000\ ft^2/day} = 48\ days$$

Drainage Net

$$\frac{694\text{ ft} \times 620\text{ ft}}{43{,}000\text{ ft}^2/\text{day}} = 10\text{ days}$$

Fabric

$$\frac{694\text{ ft} \times 620\text{ ft}}{43{,}000\text{ ft}^2/\text{day}} = 10\text{ days}$$

Drainage Controls

$$\frac{694\text{ ft} \times 620\text{ ft} \times 2\text{ ft soil}}{27\text{ ft}^3 \times 1320\text{ yd}^3/\text{day}} = 24\text{ days}$$

$$\frac{694\text{ ft} \times 620\text{ ft} \times 0.833\text{ ft}}{27\text{ ft}^3 \times 300\text{ yd}^3/\text{day}} = 44\text{ days}$$

2.11

Contingent Closure Plan

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1.0 Contingent Closure Plan

A contingent closure plan for tank systems at the Lone Mountain Facility is not required because all existing tank systems are located within secondary containment. The existing closure plans for tank systems consists of steps necessary to ensure that the waste contents are removed, and the structural components are dismantled, decontaminated, etc.

For any tank systems which cannot be clean closed, the units will be closed as landfill cells. The following landfill closure requirements will be implemented:

1. A secure final cover will be designed and constructed to minimize the migration of water through the closed landfill;
2. Cover will be placed to promote drainage, minimize erosion, and accommodate setting and subsidence;
3. Cover will be less permeable than natural subsoils on the site; and
4. Cover will function with minimum maintenance.

2.12

Closure/Post-Closure Cost Estimate

Closure/Post-Closure Cost Estimates

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Appendix 1 – Leachate Generation Volumes

1.0 Summary

The closure and post-closure cost estimates are prepared to specify the amount of money to be funded by the financial assurance mechanism to ensure that the facility may be closed in accordance with the RCRA regulation and monitored during the post-closure period. A copy of the financial assurance mechanism is located in Appendix A of Section 2.13 of this permit.

The closure and post-closure cost estimates will be adjusted, and a new financial assurance mechanism issued whenever there is a major change in operations, maintenance, or construction of the facility (e.g., new cell opened) which significantly increases the cost estimate. In addition, cost estimate changes which occur due to inflation and other minor adjustments will be determined annually.

For the standard annual revision, the most recent closure and pot-closure cost estimates will be adjusted using an inflation factor derived from the annual Implicit Price Deflator for Gross National Product as published by the U.S. Department of Commerce in its Survey of Current Business. The inflation factor will be calculated by dividing the latest published deflator by the deflator for the previous year. To arrive at the revised cost estimate, three steps are normally taken: First, any costs which are no longer applicable (e.g., cell has been closed) are subtracted from the most recent estimate. The remaining closure and post-closure estimate dollars will then be multiplied by the inflation factor. Lastly, any new amount to be funded (e.g., cell has been opened) will be added to the inflation-adjusted amount. The closure and post-closure cost estimate and underlying calculations/data used to prepare the estimate will be maintained in the facility operating record.

The information contained within this document illustrates the cost elements and methods of calculation to ensure that financial assurance is adequate. Since actual costs and specific elements may increase or decrease from year-to-year (e.g., annual leachate generation), the amount to be funded is variable. This document is provided as a demonstration of current costs, but on an annual basis, the actual cost estimate will be retained in the facility operating record. The cost estimate summary page along with the updated financial assurance mechanism will be submitted to the Oklahoma Department of Environmental Quality annually. Periodically, this document will be updated to reflect actual costs retained in the operating record.

1.1 Closure Cost Table

Table 1.1 Closure Cost	
Task	**Estimated Closure Cost**
Inventory Management	$1,319,997
Groundwater Monitoring	$193,680
Landfill Closure	$6,066,423
Leachate Management	$1,984,350
Closure Sampling and Certification	$142,620
Total Closure Cost	**$10,117,714**

1.2 Post Closure Cost (First Year)

The Post-Closure cost for the first year is estimated to be approximately $4,116,688.

1.3 Cell 5 Corrective Action (First Year)

Table 1.3 Cell 5 Corrective Action	
Task	**Cost**
Groundwater Monitoring	$7,518
Groundwater Pumping	$111,639
Administrative Review/Reporting	$5,011
Total Annual Cost	**$124,168**

Total closure, post-closure, and Cell 5 cost over 30 years is estimated to be approximately $28,445,134.

2.0 Closure Cost

Since the number of active landfill cells will fluctuate, and a variety of other factors may change, the costs for closing the entire Lone Mountain Facility can vary each year. The closure and post-closure cost estimates considers the most expensive scenario which would occur if the entire facility closed immediately. Refer to Tables 1 and 2 of the Closure Plan. At the projected closure of the entire facility in 2040, the landfill cells, tank systems, Drum Dock, and Container Management Building would be closed.

The landfill cell cost estimates are based on current operations and recent cell construction at the Lone Mountain facility. Closure costs for the general facility are based on published prices. All costs are based on 2020 dollars. The calculations are based on projected facility operations. Since actual facility operations may be different, the assumed closure period for the landfill cells is only an estimate.

2.1 Assumptions

To determine the closure cost estimates for each area, the following basic assumptions were made:

1. As much of the existing facilities as possible will be used for performing the closure work.
2. Adequate landfill capacity is available for placing all the solid and stabilized waste in an existing cell.
3. All stabilization will be performed using the existing stabilization facilities.

4. The Wastewater Treatment System is functioning and available for treating all applicable liquid waste.

5. Facility equipment is available for performing clean-up work.

6. The closure plan stipulates the following conditions:

    a. 20% of all containers will contain solids having no free liquids and can be landfill disposed.
    b. 60% of all containers will contain solids or sludges which can be stabilized and landfilled.
    c. 10% of all containers will contain organic liquids which will be shipped off site for use as fuel.
    d. 10% of all containers will contain inorganic liquids which can be treated in the wastewater system.

7. The following assumptions are made regarding the tank capacity of the Wastewater Treatment System:

    a. 40% of the volume is sludge which can be stabilized and landfilled.
    b. 60% of the volume is liquids which can be treated in the Wastewater Treatment System.

8. The Container Management Surge Tanks can be treated as follows:

    a. 50% of all capacity contains waste fuel which can be recycled as kiln fuel.
    b. 12% of all capacity contains sludges which can be stabilized and landfilled.
    c. 38% of all capacity contains inorganic liquids which can be treated in the Wastewater Treatment System.

9. Stabilization of solids results in a 100% volume increase.

10. Closure duration is one year.

2.2 Basis for Unit Cost

The basis for unit cost are approximated in the tables below and are based on the following two criteria:

- Stabilization Cost (Current lone Mountain Cost)

- Off-Site Deep Well Injection or Wastewater Treatment

Unit Cost	
Item	Estimated Unit Cost
Landfilling Cost	$0.00
Load Bulk Waste Into Truck	$2.12
Transport 1 Mile	$0.17
Total	$2.29/CY

Wastewater Treatment Price (Current Lone Mountain Cost)	$0.33
Cement Kiln Disposal for Fuel (Current Market Price)	$0.25
Unit Price of Steam Cleaning Tank Interiors in Level B PPE	$2.82
Decontaminate Heavy Equipment	$175.51/EA
Cat 12 Motor Grader	$440.00/Hr
3 CY Loader	$39.00/Hr
10 CY Dump Truck	$26.00/Hr
Groundwater Analytical Testing (Current Mountain Facility Cost)	
Sample for RCRA/HSWA Permit Spring Event	$432.00
Sample for RCRA/HSWA Permit Spring Event	$432.00
Sample for Post Closure Permit Spring Event	$567.00
Sample for Post Closure Permit Fall Event	$273.00
3500 Gallon Water Truck (Source: Dataquest Bluebook)	$24.00/Hr
1 Backhoe/Loader (Source: Dataquest Bluebook)	$19.00/Hr

2.3 Waste Inventory Management

Tank volume capacity is detailed in the Tank System Data Summary Table. The following information regarding tank capacity is extracted from that table. The following capacities include operational tanks, out-of-service tanks that are in place, and future tanks that are expected to be constructed in the near future, if any.

2.3.1 Tanks

TANKS		
FUNCTIONAL AREA	GALLONS	ASSUMED CONTENTS
Truckwash/Unloading Area	1,191	Condition 7 Above
Neutralization Reactor	2,538	Condition 7 Above
Rotary Drum Filter Containment	760	Condition 7 Above
Acid Tank Containment	39,767	Condition 7 Above
Caustic/Reactives Containment (CT1-CT4)	132,432	Condition 7 Above
Final Effluent/Leachate Storage (EF1 & EF2)	714,844	Condition 7 Above

TANKS		
FUNCTIONAL AREA	GALLONS	ASSUMED CONTENTS
Final Treatment Evaporator Distillation Area	22,057	Condition 7 Above
Evaporator Overflow Containment	5,514	Condition 7 Above
Miscellaneous Tank Systems (T6)	1,409,947	Condition 7 Above
Stabilization Tanks	35,904	Condition 7 Above
Total Tank Capacity To Be Considered	**2,364,954 gallons**	

2.3.2 Containers

CONTAINERS		
FUNCTIONAL AREA	GALLONS	ASSUMED CONTENTS
Container Management Building	182,490	Condition 6 Above
Drum Dock	24,365	Condition 6 Above
Total Container Volume	**206,855 gallons**	

2.3.3 Total Inventory

Volume to be stabilized/landfilled — **Gallons**

Wastewater treatment storage = 0.4 x 2,364,954 = 945,982
Container Storage = 0.6 x 206,855 = 124,113

TOTAL 1,070,095

Total in Cubic Yards = 2 x 1,070,095 = 2,140,190 Gallons
2,140,190/7.48/27 = 10,597 CY
(7.48 gal/CF, 27 CF/CY)

Volume For Wastewater Treatment Plant — **Gallons**

Wastewater treatment storage = 0.6 x 2,364,954 = 1,418,972
Container Storage = 0.1 x 206,855 = 20,686

TOTAL 1,439,658

Volume to be Directly Landfilled		**Gallons**
Stabilization Tanks	=	35,094
Container Storage	= 0.2 x 206,855 =	41,371
	TOTAL	**77,275**
Total in Cubic Yards	= 77,275 / 7.48 / 27 =	383 CY
		(7.48 gal/CF, 27 CF/CY)

Volume to be Sent to Cement Kiln for Fuel		**Gallons**
Container Storage	= 0.1 x 206,855 =	20,686
	TOTAL	**20,686**

INVENTORY MANAGEMENT TOTAL COST

Stabilization	1,070,095 x 0.25 =	$267,524
Stabilized Volumes Landfilled	10,597 x 2.29 =	24,267
Treatment at Wastewater Plant	1,439,658 x 0.25 =	1,022,157
Direct Landfilling	383 x 2.29 =	877
Sent to Cement Kiln as Fuel	20,686 x 0.25 =	5,172
TOTAL INVENTORY MANAGEMENT COST		**$1,319,997**

2.4 Facility Decontamination

2.4.1 Tanks and Contaminated Areas

The total internal surface area of the tanks in Section 2.3.1 was calculated using the dimensions tabulated in Table 1 of the Wastewater Treatment System Procedures.

Total Internal Area= 44,754 square feet (SF)

Of this total, 29,500 SF applies to open-top tanks and 15,254 SF applies to enclosed tanks.

The total area of the secondary containment was estimated from the secondary containment volumes tabulated in Table 1 of the Tank System Secondary Containment Systems. A very conservative average wall height of 1 food was used to calculate the surface area of the concrete containment. For double-wall tanks, the surface area of the outer tank was used.

Total Secondary Containment Area = 112,486 SF

All surfaces are required to be washed and rinsed according to the permit. It is estimated there are 7,800 feet of pipe associated with the tanks. A four man crew will be able to wash and rinse 300 feet/day. (Labor at $15.00/hour and a steam cleaner at 1.00/hour).

- Residual liquid production is estimated to be 0.3 gal/sf.
- Residual solid production is estimated to be 0.04 gal/sf.
- Liquids = 0.3 x (112,486 + 44,754) x 2 = 94,344 gallons.
- Solids = 0.04 x (112,486 + 44,754) = 6,290/7.48/27 = 31 CY (7.48 gal/CF, 27 CF/CY)

Tanks and Containment Area Decontamination

Tank Interiors	2 x 15,254 x 2,86 =	$86,033
Secondary Containment And Open Topped Tanks	2 x 141,986 x 0.57=	$161,864
Piping	[(4x$15) + $1] x 8Hrs x (7800/300) =	$12,688
Off-site Deep Well Injection Or Wastewater Treatment	94,344 x 0.90 =	$90,570
Landfilling Solids	31 x 2.29 =	$71
	TOTAL	**$351,226**

2.4.2 Roadway Surfaces

The following assumptions are made for the calculated cost of decontamination of roadway surfaces.

- 15,000' long x 24' wide = 360,000 SF = 8.26 acres
- Assume productivity of 2+ acres/day for 4 days work
- Assume average 1" of soil removed from entire area
- 360,000sf x 1/12/27 = 1,111 CY removed for disposal

Roadway Surface Decontamination

Cat 12 Motor Grader	4 days x 8 Hours x $40/hr =	$1,280
3 CY Loader	4 days x 8 Hours x $39/hr =	$1,248
10 CY Loader	4 days x 8 Hours x $26/hr =	$832
3 Equipment Operators	3 x 4 days x 8 Hours x $15/hr =	$1,440
1,111 CY for Disposal @$2.29/CY	=	$2,544
	TOTAL	**$7,344**

2.4.3 Equipment Decontamination

Bulldozers	2
Trackhoes	4
Off-Road Dump Trucks	3
Compactor	1
Screening Plants	2
Water Trucks	3
Guzzler Water Truck	1
Motor Grader	1
Front-End Loader	2
Shredders	2
Equipment Total	21

TOTAL 21 x $175.51 ea = $3,686

2.4.4 Total Facility Decontamination Cost

Tanks and Containment Surfaces	$351,226
Roadway Surfaces	$7,344
Equipment Decontamination	$3,686
TOTAL	**$362,296**

2.5 Groundwater Monitoring

Two sampling events occur every year and the closure is anticipated to take one year. There are currently 61 wells being monitored at the Lone Mountain Facility. Sixty-one (61) samples are collected per sampling event (1 per well). Forty-one (41) wells are subject to the RCRA/HSWA Operations Permit. Twenty (20) wells are subject to the Post-Closure Permit.

An 8 person crew working 10 hours/day will take 10 days to do the long event sampling and 8 days to do the short event sampling. This amounts to 180 man hours per year.

The crew cost = 7 x $20/hr = 1 x $60/hr = $200/hr

Four-man weeks (160 hours) of effort is required for administration and reporting at $60 per hour, per event. Reproduction costs are $1000 per event, with two events per year, amounting to $2,000 per year.

YEARLY GROUNDWATER MONITORING COSTS		
TASK	AMOUNT	COST
Crew Cost	$200/hr x 180 hrs	$36,000
Analysis	$360.00 each x 41 samples	$69,085
	$360.00 each x 41 samples	$47,355
	$567 each x 20 samples	$11,340
Shipping Costs	$273 each x 20 samples*	$5,460
Administration and Reporting	$180 x 18 days	$3,240
Reproduction Costs	320 hours x $60/hour	$19,200
Total		$191,680

*Shipping costs are $180 per day of sampling.

2.6 Landfill Closure

Closures of Subcells in Cell 15 began in 2011. The current Closure Cost Estimate accounts for these activities.

2.7 Leachate Management

2.7.1 Leachate Production and On-Site Treatment Cost

Leachate-collection and rainfall records were examined from 2009 through 2019 to estimate current and projected leachate quantities.

The Drum Cell and Cells 1 through 8 are all closed. These closed units can be expected to produce approximately 643,000 gallons of leachate per year. Additionally; an average of 250,000 gallons of water, which is treated as leachate, is recovered from the Cell 5 RFI activities, making the total annual volume of leachate production from these cells approximately 893,000 gallons per year.

Cells 10 and 11 were closed in 1997 and 1996, respectively. The leachate volumes produced from each of these closed landfills has now stabilized, although it varies somewhat from year to year, in direct proportion to fluctuations in annual rainfall. At this time, these two cells combined are producing approximately 176,000 gallons of leachate per year.

Cells 12 and 13 were closed in 1997 and 1996, respectively. The leachate volumes produced from each of these closed landfills has now stabilized, although it varies somewhat from year to year, in direct proportion to fluctuations in annual rainfall. At this time, these two cells combined are producing approximately 127,000 gallons of leachate per year.

Cell 14 was closed in 2002. The leachate volume produced from this closed landfill has now stabilized, although it varies somewhat from year to year, in direct proportion to fluctuations in annual rainfall. At this-time, this cell is producing approximately 127,000 gallons of leachate per year.

Cell 15 is currently open and in use. The leachate production from this cell is highly erratic, corresponding largely to annual rainfall amounts. This cell has been producing an average volume of approximately 4,080,000 gallons of leachate per year. However, this cell is scheduled to begin closure of full subcells starting in 2011.

Therefore, it can be assumed that leachate production from the closed subcells will rapidly decline to rates per unit of surface area similar to those demonstrated from Cells 10, 11, 12, 13, and 14.

TOTAL LEACHATE PRODUCTION	
LOCATION	GALLONS
Drum Cells & Cells 1 – 8	893,000
Cells 10 & 11	176,000
Cells 12 & 13	127,000
Cell 14	47,000
Cell 15	4,080,000
Total	**5,323,000**

On-Site Leachate Treatment Cost: 5,323,000 x $0.33 = $1,756,590

2.7.2 Leachate Collection Cost

2 – 3,500 Gallon Water Trucks at $24/Hr
2 – Truck Divers at $15/Hr

<u>Collection Cost:</u>

2 x (24.00 + 15.00) x 8 hrs x 365 days = $227,760

2.7.3 Total Leachate Management Cost

TOTAL LEACHATE MANAGEMENT COST	
Item	Cost
On-Site Treatment Cost	$1,756,590
Collection Cost	$227,760
Total	**$1,984,350**

2.7.4 Off-Site Deep Well Injection or Wastewater Treatment

OFF-SITE TREATMENT COST	
Item	Cost
5,323,000 x $0.96	$5,110,080
Collection Cost	$227,760
Total	**$5,337,840**

2.8 Certification, Sampling, and Decontamination

2.8.1 Sampling and Analysis to Confirm Decontamination

Below outlines the number of samples and analyses of wash water generated from decontamination.

NUMBER OF SAMPLES FROM WASH WATER	
AREA	NO. OF SAMPLES
2 Waste Fuel Tanks	2
Waste Fuel Tanks Containment Area	1
Stabilization Containment Area	7
Drum Dock Area	2
Container Management Structure	8
Wastewater Treatment Plant	14
28 Tanks	40
Total	74

The Closure Plan requires analyzing for oil and grease, phenols, RCRA metals, TOX, TOC, and cyanides. The current cost for this water analyses is $360.00/sample.

Total Water Analyses Price:
74 samples x $360.00 = $26,640

Number of soil samples and analyses:

Number of Samples from Soil	
Area	No. of Samples
Unloading and Sampling Area	1
Stabilization Area	2
Drum Dock	4
Roadways	10
Total	17

The current cost for Appendix IX Constituents is $1,340.00 per sample.

Total Soil Analysis Price:
17 samples x $1,340 = $22,780

2.8.2 Certification by Independent Professional Engineer

It is estimated this activity will occur over a four (4) month period. It will require the services of a Professional Engineer on a part-time basis, two staff engineers on a full-time basis, and part time clerical help.

Item	Amount	Cost
Professional Engineer	100 hours x $74.00/hour	$7,400
Engineering Staff	1,400 hours x $57.00/hour	$79,800
Clerical	160 hours x $25.00/hour	$4,000
Report Reproduction	Per Report	$2,000
Total		$93,200

2.8.3 Total Cost of Certification, Sampling, and Decontamination

Item	Cost
Water Analysis	$26,640
Soil Analysis	$22,780
Certification	$93,000
Total	$142,620

3.0 Post-Closure Cost

3.1 Groundwater Monitoring

There are two (2) required sampling event s each year, and there are currently 61 wells being monitored at Lone Mountain. Sixty-one (61) samples are collected per sampling event (1 sample per well). Forty-one (41) wells are subject to the requirements of the RCRA/HSWA Operations Permit. Twenty (20) wells are subject to the Post-Closure Permit.

An 8 person crew, working 10 hours/day will take 10 days to do the long event sampling, and 8 days to do the short event sampling. This equates to 180 crew hours per year.

Crew cost = (7 x $20.00/hr) + (1 x $60.00/hr) = $200.00/hr

Four man weeks (160 hours) of effort is required for administration and reporting at $60.00/hr. Reproduction costs are $1,000.00 per event for two events a year, amounting to $2,000.00 per year. Shipping costs are $180.00 per day of sampling. The following table summarizes the annual cost of groundwater monitoring.

TOTAL YEARLY COST OF GROUNDWATER MONITORING		
ITEM	AMOUNT	COST
Crew Cost	$200/hr x 180 hrs	$36,000
Analysis	$360.00 each x 41 samples	$69,085
	$360.00 each x 41 samples	$47,355
	$567 each x 20 samples	$11,340
	$273 each x 20 samples	$5,460
Shipping Cost	$180 x 18 days	$3,240
Administration and Reporting Cost	320 hours x $60/hr	$19,200
Reproduction Costs	Per Report	$2,000
Total		**$193,680**

3.2 Leachate Management

3.2.1 Leachate Volume Estimate

The Drum Cell and Cells 1 through 8 are currently predicted to produce 893,000 gallons of leachate per year, and this volume is likely to continue. Cells 10, 11, 12 and 14 have stabilized at a combined average annual leachate volume of approximately 350,000 gallons per year. The total annual leachate volumes estimate is summarized in the table below.

Area	Gallons of Leachate
Drum Cell and Cells 1-8	893,000
Cells 10, 11, 12, 13, & 14	350,000
Cell 15	4,080,000
Total Annual Volume	**5,323,000**

Disposal by Off-Site Deep Well or Wastewater Treatment

5,323,000 x $0.90 = $4,790,700

3.2.2 Leachate Collection Cost

Item	Cost
1 3,500 Gallon Water Truck	$24/hour
1 Truck Driver	$15/hour
Total Collection Cost*	**$16,244**

*($24.00 + $15.00) x 8 hrs x 52 days

3.2.3 Total Leachate Management Cost

Item	Cost
Off-Site Disposal	$5,138,880
Collection Cost	$16,244
Total Management Cost	**$5,155,104**

3.3 Maintenance Activities

3.3.1 Monitoring System Maintenance

Item	Cost
Technician (200 hrs x $20.00/hr)	$4,000
Well Pump Replacement: 1 Pump/3 Years = .33 x $1,400	$467
Total Monitoring System Maintenance	$4,467

3.3.2 Leachate System Maintenance

Leachate Pump Replacement:

6 pumps per year = 6 x $1,500.00 = $9,000

3.3.3 Landfill Cap Maintenance

Item	Cost	Sum
1 Backhoe/Loader	$19.00/hr x 8 hrs x 12 days	$1,824
1 Operator	$15.00/hr x 8 hrs x 12 days	$1,440
1 Pickup	$7.00/hr x 8 hrs x 12 days	$672
1 Laborer	$12.00/hr x 8 hrs x 12 days	$1,152
Total Landfill Cap Maintenance		**$5,088**

3.3.4 Weekly Inspections

Item	Cost	Sum
1 Pickup	$7.00/hr x 8 hrs x 52 days	$2,912
1 Inspector	$18.00/hr x 8 hrs x 52 days	$7,488
Total Weekly Inspections		**$10,400**

3.3.5 Total Maintenance Activities

Item	Cost	Sum
Professional Engineer	48 hrs x $74.00/hr	$3,552
Technical Staff Observation	192 hrs x $57.00/hr	$10,944
Clerical	48 hrs x $25.00/hr	$1,200
Total Administrative		**$15,696**

3.4 Annual Administrative Review/Reporting

Item	Cost	Sum
Professional Engineer	48 hrs x $74.00/hr	$3,552
Technical Staff Observation	192 hrs x $57.00/hr	$10,944
Clerical	48 hrs x $25.00/hr	$1,200
Total Administrative		**$15,696**

3.5 Final Post-Closure Certification

Item	Cost	Sum
Professional Engineer	60 hrs x $74.00/hr	$4,400
Clerical	20 hrs x $25.00/hr	$500
Total Post-Closure		**$4,900**

4.0 Cell 5 Corrective Action

4.1 Groundwater Monitoring

Two sampling events occur every year under the current monitoring schedule. The total length of the monitoring period is estimated to be 30 years. There are 14 wells to be monitored. MW5-A2 and MW5-A3 will be monitored for Cell 5 Corrective Action purposes through the semi-annual facility monitoring program. The wells will be monitored for four (4) volatile organic compounds by SW-846 Methods 8240 and8260.

A two person crew working eight hours per day will take one day to perform each sampling event for a total of 16 hours per year.

Two days (16 hours) of effort per year will be required for groundwater monitoring administration and reporting at $60.00/hr. Reproduction and sample shipping costs are relatively small and incorporated into the analytical and administrative costs. The total yearly cost of groundwater monitoring for cell 5 is summarized in the table below.

Item	Cost	Sum
Analysis	$175.00/ea x 28 samples	$4,900
Two Man Crew Cost	(2x$40.00/hr) x 16.00/hrs	$640
Administration and Reporting	$60.00/hr x 16.00/hrs	$960
Total Cell 5 Groundwater Monitoring Cost		**$6,500**

5.0 Cell 15 Closure Cost

Currently Cell 15 is the active waste disposal cell at the Lone Mountain Facility. This Cell incorporates a "moving wall" design strategy, which allows for additional subcells to be added during operation of the cell. At this time Subcells 1, 2, 3, 4, 5, 6, 7 and 8 are full, and Subcells 9, 10, 11, 12, and 13 of Cell 15 are active. Additional expansion of Cell 15 including Subcells 14,15, 16, 17, 18, 19, 20, 21, and 22 have been permitted but not constructed. Construction of these additional subcells is planned within the upcoming years. The following Table details the projected Cell 15 Closure Costs.

Cell 15 Closure Estimate

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	RATES	TOTAL COST
Section 1.0 - Waste Grading					
1.1	Grade Preparing	Lump Sum	1	$75,000.00	$75,000.00
1.2	Surveying	Lump Sum	1	$50,000.00	$50,000.00
Total Waste Grading Cost					**$125,000.00**
Section 2.0 - Earthwork					
2.1	Mob/Demob	Lump Sum	N/A	$75,000.00	$75,000.00
2.2	Unclassified Soil	Cu. Yard	7,200	$6.40	$46,080.00
2.3	Perimeter Clay	Cu. Yard	3,800	$7.30	$27,740.00
2.4	Soil Protective Cover	Cu. Yard	29,000	$5.50	$159,500.00
2.5	Type I Granular Filter	Cu. Yard	3,600	$53.25	$191,700.00
2.6	Type II Granular Filter	Cu. Yard	4,800	$42.25	$202,800.00
2.7	Type V RipRap	Cu. Yard	7,200	$36.50	$262,800.00
2.8	Settlement Monument	Each	38	$40.00	$1,520.00
2.9	4″ Perforated HDPE Pipe	Linear Foot	1,900	$27.50	$52,250.00
2.10	6″ Perforated HDPE Pipe	Linear Foot	1,900	$18.00	$34,200.00
2.11	18″ HDPE Pipe	Linear Foot	500	$65.00	$32,500.00
2.12	Gas Vents	Each	5	$235.00	$1,175.00
2.13	Concrete Inlets	Each	2	$6,000.00	$12,000.00
Total Earthwork Cost					**$1,099,265.00**
Section 3.0 - Geosynthetics					
3.1	60 mil HDPE	Sq. Yard	43,100	$4.83	$208,173.00
3.2	GCL	Sq. Yard	43,100	$4.42	$190,502.00
3.3	Geotextile Fabric	Sq. Yard	43,100	$1.65	$71,115.00
3.4	Geonet	Sq. Yard	43,100	$2.33	$100,423.00
3.5	Mob/Demob	Linear Foot	1	$5,000.00	$5,000.00
3.6	Weld Linear Edge	Linear Foot	1,900	$5.00	$9,500.00
Total Geosynthetics					**$584,713.00**
Total Construction Cost (sum of Section 1.0, 2.0, and 3.0)					**$1,808,978.00**
Section 4.0 - Project Management					
4.1	Project Management	%	$1,808,978.00	5%	$90,448.90
4.2	Quality Control	%	$1,808.978.00		$108,538.68
4.3	Quality Assurance	%	$1,808.978.00		$54,269.34
4.4	Design/Bid Documents	%	$1,808.978.00		$90,44.90
Total Project Management Cost (Section 4)					**$343,705.82**
Total Closure Cost					**$2,152,683.82**

Appendix 1

LEACHATE GENERATION VOLUMES
2006 – 2009

Leachate Generated Volumes

Landfill	Landfill Leachate Volumes by Year				
	2006 total	2007 Total	2008 Total	2009 Total	4-yr Average
Drum Cell-COL.	2,107	4,039	3,499	2,782	3,107
Drum Cell-DET.	29,912	101,276	97,461	56,374	71,256
Cell 1-DET	836	0	16,481	14,195	7,878
Cell 2-DET	2,272	9,272	19,298	12,195	10,759
Cell 3-COL	2,525	2,591	2,066	2,277	2,365
Cell 3-DET	14,998	17,797	22,189	19,220	18,551
Cell 4-DET	193,155	207,476	204994	221,654	206,820
Cell 5-DET	80,045	141,356	172,283	99,484	123,292
Cell 6-DET	37,357	30,439	50,257	45,204	40,814
Cell 7-DET	64,896	80,947	197,901	175,795	130,135
Cell 8-COL	-	0	-	-	-
Cell 8-DET	19,899	28,262	32,297	29,039	27,374
Cell 10-COL	4	215	74	-	73
Cell 10-TERT-DET	412	15,887	7,248	7,557	7,776
Cell 10-D-1	1,866	4,839	8,921	5,124	5,188
Cell 10-D-2	243	5,052	4,725	5,081	3,775
Cell 11-COL	5,923	6,494	2,438	1,459	4,079
Cell 11-D-1	23,334	135,224	119,280	91,421	92,315
Cell 11-D-2	20,326	98,577	69,615	62,767	62,821
Cell 12-COL	684	538	268	8	375
Cell 12-D-1	6,649	54,385	48,759	37,833	36,907
Cell 12-D-2	19,587	74,662	73,412	54,547	55,552
Cell 13-COL	5,809	4,542	3,925	3,500	4,444
Cell 13-D-1	2,892	10,160	4,590	6,023	5,916
Cell 13-D-2	3,947	30,324	35,812	25.072	23,789
Cell 14-COL	24,909	23,718	14,182	8,525	17,834
Cell 14-D-1	13,955	6,724	3,742	2,825	6,812
Cell 14-D-2	4,260	40,638	17,425	26,632	22,239
Cell 15-COL	962,096	6,138,324	4,302,794	4,526,634	3,982,462
Cell 15-D-1	52,247	30,180	72,305	126,242	70,744
Cell 15-D-2	7,337	21,904	47,171	30,801	26,803
Cell 5-RFI-14	148,550	289,707	281,803	281,832	250,473

2.13

Financial Assurance Mechanism

Table of Contents

1.0 Financial Assurance Mechanism 1

Appendix A – Lone Mountain Facility Financial Assurance Mechanism

1.0 Financial Assurance Mechanism

Contained in Appendix A is the Lone Mountain Facility financial assurance mechanism in the amount calculated according to the current closure, post-closure, and corrective action cost estimate procedures located in the facility operating record and/or Closure/Post Closure Cost Estimate. In the future, the facility will adjust the cost estimate and financial assurance mechanism as necessary to reflect changes to the facility design and/or operation (e.g., opening of a new subcell/phase of Cell 15) and/or annual inflation factor.

APPENDIX A

Lone Mountain Facility Financial Assurance Mechanism

Clean Harbors Environmental Services, Inc.
610 131st Place
Hammond, IN 46327
219-746-5050
800.282.0058
www.cleanharbors.com

VIA FEDERAL EXPRESS TRK #777310410869

December 20, 2019

Ms. Carol Bartlett, Environmental Programs Specialist
Land Protection Division
Oklahoma Department of Environmental Quality
707 North Robinson Street
Oklahoma City, OK 73102

RE: Financial Assurance Bond Renewal and Annual Inflation Increases
Clean Harbors Lone Mountain, LLC (Waynoka, OK 73860) - EPA ID No. OKD065438376
Clean Harbors Lone Mountain, LLC (Avard, OK 73717) - EPA ID No. OK0000070136
Tulsa Disposal, LLC (South Tulsa, OK 74107) - EPA ID No. OKD000632737

Dear Ms. Bartlett:

Please find enclosed an original signed and sealed Rider for Bond number K08644925, which provides financial assurance for closure, post-closure, and corrective action for the three (3) Clean Harbors facilities located in Oklahoma. The Bond has been renewed for another year and the financial assurance coverages it provides have been increased for inflation, as detailed below. The Rider is effective December 31, 2019.

The inflation increases were calculated by multiplying the 2018 cost estimates by the annual inflation factor 1.0223. This inflation factor was found on the Oklahoma DEQ web site: https://www.deq.ok.gov/wp-content/uploads/land-division/IPD2019GDPandGNP.pdf, "Annual Inflation Adjustments for Solid Waste Disposal Facilities". A copy is enclosed.

Clean Harbors Lone Mountain, LLC - EPA ID No. OKD065438376

Closure:	$14,322,120.11 x 1.0223 = $14,641,503.39
Post-Closure:	$19,423,230.94 x 1.0223 = $19,856,368.99
Corrective Action:	$3,926,073.23 x 1.0223 = $4,013,624.66

Clean Harbors Lone Mountain, LLC - EPA ID No. OK0000070136
Closure: $601,287.05 x 1.0223 = $614,695.75

Tulsa Disposal, LLC - EPA ID No. OKD000632737
Closure: $1,379,404.36 x 1.0223 = $1,410,165.08

**Please note that the bond submitted with this duplicate letter on Dec. 19th was for our Buttonwillow, CA facility. Please except this correct bond in its place, and return the DTSC bond to my home office:
Clean Harbors Environmental Services, Inc.
C/O Pam Harvey
2233 Grand Ave.
Schererville, IN 46375

If you have any questions or concerns regarding this submittal, please feel free to contact me at harvey.pamela@cleanharbors.com or at 219-746-5050.

Sincerely,

Pamela K. Harvey

Pamela K. Harvey, CHMM
Environmental Compliance Manager

Enclosure

RIDER

TO BE ATTACHED TO AND FORM PART OF

CLOSURE — NO. K08644925
(Bond Type) *(Bond Number)*

IN FAVOR OF OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY
(Obligee)

ON BEHALF OF CLEAN HARBORS LONE MOUNTAIN, LLC; TULSA DISPOSAL, LLC.
(Principal)

EFFECTIVE December 31, 2012
(Original Effective Date)

IT IS AGREED THAT, in consideration of the original premium charged for this bond, and any additional premium that may be properly chargeable as a result of this rider.

The Surety, WESTCHESTER FIRE INSURANCE COMPANY
hereby gives its consent to change;

Bond/Contract Amount — Old Bond Amount = $39,652,115.69 TO New Bond Amount: $40,536,357.87

(of) the attached bond FROM:
Waynoka Oklahoma Closure Costs: $14,322,120.11 to $14,641,503.39 Lone Mountain Facility EPA ID No. OKD065438376
Waynoka Oklahoma Post Closure Costs: $19,423,230.94 to $19,856,368.99
Waynoka Oklahoma Corrective Action: $3,926,073.23 to $4,013,624.66

TO:
Avard Oklahoma Closure Costs: $601,287.05 to $614,695.75 EPA ID No. OK0000070136 Clean Harbors Lone Mountain, LLC
Tulsa Oklahoma Closure Costs: $1,379,404.36 to $1,410,165.08 EPA ID No. OKD000632737 Tulsa Disposal, LLC.

Current Total Closure Costs: $16,302,811.52 to $16,666,364.22
Current Total Post Closure Cost Estimate: $19,423,230.94 to $19,856,368.99
Current Corrective Action Costs: $3,926,073.23 to $4,013,624.66

Total Penal Sum of Bond: $40,536,357.87

REASON: Increase due to Inflation

Effective December 31, 2019

PROVIDED, however that the attached bond shall be subject to all its agreements, limitations, and conditions except as herein expressly modified, and that the liability of the Surety under the attached bond and under the attached bond as changed by this rider shall not be cumulative.

SIGNED, AND SEALED this 10th **day of** December, 2019.

CLEAN HARBORS LONE MOUNTAIN, LLC; TULSA DISPOSAL, LLC.
Principal

Accepted By

WESTCHESTER FIRE INSURANCE COMPANY
Surety

JOLINE L. BINETTE, ATTORNEY-IN-FACT

CHUBB

Power of Attorney

Westchester Fire Insurance Company | ACE American Insurance Company

Know All by These Presents, that **WESTCHESTER FIRE INSURANCE COMPANY** and **ACE AMERICAN INSURANCE COMPANY** corporations of the Commonwealth of Pennsylvania, do each hereby constitute and appoint **Joline L. Binette, Melanie A. Bonnevie, Nancy Castonguay, Heidi Rodzen and Robert Shaw, Jr. of Lewiston, Maine --**

each as their true and lawful Attorney-in-Fact to execute under such designation in their names and to affix their corporate seals to and deliver for and on their behalf as surety thereon or otherwise, bonds and undertakings and other writings obligatory in the nature thereof (other than bail bonds) given or executed in the course of business, and any instruments amending or altering the same, and consents to the modification or alteration of any instrument referred to in said bonds or obligations.

In Witness Whereof, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY have each executed and attested these presents and affixed their corporate seals on this **15th** day of **August, 2019.**

Dawn M. Chloros, Assistant Secretary

Stephen M. Haney, Vice President

WESTCHESTER FIRE INSURANCE COMPANY | ACE AMERICAN INSURANCE COMPANY CORPORATE SEAL

STATE OF NEW JERSEY

County of Hunterdon ss.

On this **15th** day of **August, 2019,** before me, a Notary Public of New Jersey, personally came Dawn M. Chloros, to me known to be Assistant Secretary of WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY, the companies which executed the foregoing Power of Attorney, and the said Dawn M. Chloros, being by me duly sworn, did depose and say that she is Assistant Secretary of WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY and knows the corporate seals thereof, that the seals affixed to the foregoing Power of Attorney are such corporate seals and were thereto affixed by authority of said Companies; and that she signed said Power of Attorney as Assistant Secretary of said Companies by like authority; and that she is acquainted with Stephen M. Haney, and knows him to be Vice President of said Companies; and that the signature of Stephen M. Haney, subscribed to said Power of Attorney is in the genuine handwriting of Stephen M. Haney, and was thereto subscribed by authority of said Companies and in deponent's presence.

Notarial Seal

KATHERINE J. ADELAAR NOTARY PUBLIC NEW JERSEY

KATHERINE J. ADELAAR
NOTARY PUBLIC OF NEW JERSEY
No. 2316685
Commission Expires July 16, 2024

Notary Public

CERTIFICATION

Resolutions adopted by the Boards of Directors of WESTCHESTER FIRE INSURANCE COMPANY on December 11, 2006 ; ACE AMERICAN INSURANCE COMPANY on March 20, 2009:

"RESOLVED, that the following authorizations relate to the execution, for and on behalf of the Company, of bonds, undertakings, recognizances, contracts and other written commitments of the Company entered into in the ordinary course of business (each a "Written Commitment"):

(1) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise.

(2) Each duly appointed attorney-in-fact of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise, to the extent that such action is authorized by the grant of powers provided for in such person's written appointment as such attorney-in-fact.

(3) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to appoint in writing any person the attorney-in-fact of the Company with full power and authority to execute, for and on behalf of the Company, under the seal of the Company or otherwise, such Written Commitments of the Company as may be specified in such written appointment, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.

(4) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to delegate in writing to any other officer of the Company the authority to execute, for and on behalf of the Company, under the Company's seal or otherwise, such Written Commitments of the Company as are specified in such written delegation, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.

(5) The signature of any officer or other person executing any Written Commitment or appointment or delegation pursuant to this Resolution, and the seal of the Company, may be affixed by facsimile on such Written Commitment or written appointment or delegation.

FURTHER RESOLVED, that the foregoing Resolution shall not be deemed to be an exclusive statement of the powers and authority of officers, employees and other persons to act for and on behalf of the Company, and such Resolution shall not limit or otherwise affect the exercise of any such power or authority otherwise validly granted or vested."

I, Dawn M. Chloros, Assistant Secretary of WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY (the "Companies") do hereby certify that

(i) the foregoing Resolutions adopted by the Board of Directors of the Companies are true, correct and in full force and effect.
(ii) the foregoing Power of Attorney is true, correct and in full force and effect.

Given under my hand and seals of said Companies at Whitehouse Station, NJ, this **10th day of December, 2019.**

WESTCHESTER FIRE INSURANCE COMPANY | ACE AMERICAN INSURANCE COMPANY CORPORATE SEAL

Dawn M. Chloros, Assistant Secretary

IN THE EVENT YOU WISH TO VERIFY THE AUTHENTICITY OF THIS BOND OR NOTIFY US OF ANY OTHER MATTER, PLEASE CONTACT US AT:
Telephone (908) 903-3493 Fax (908) 903-3656 e-mail: surety@chubb.com

2.14

Sudden and Non-Sudden Accidental Occurrence Insurance

Clean Harbors Environmental Services, Inc.
610 131st Place
Hammond, IN 46327
219-746-5050
800.282.0058
www.cleanharbors.com

VIA FEDERAL EXPRESS TRK #777150701600

December 4, 2019

Ms. Carol Bartlett, Environmental Programs Specialist
Land Protection Division
Oklahoma Department of Environmental Quality
707 North Robinson
Oklahoma City, OK 73102

RE: Hazardous Waste Facility Certificates of Liability Insurance
Clean Harbors Lone Mountain LLC, (Waynoka, OK) – EPA ID No. OKD065438376
Clean Harbors Lone Mountain LLC (Avard, OK) – EPA ID No. OK0000070136
Tulsa Disposal LLC – EPA ID No. OKD000632737
Safety-Kleen Systems, Inc. – multiple sites

Dear Ms. Bartlett:

Please find enclosed four (4) original signed Hazardous Waste Facility Certificates of Liability Insurance for the facilities referenced above. Per your email request dated November 27, 2019; the certificates have been revised to meet the requirements of the 40CFR151(j) form.

If you have any questions regarding this submittal feel free to contact me at 219-746-5050 or Harvey.Pamela@cleanharbors.com.

Sincerely,

Pamela K. Harvey

Pamela K. Harvey, CHMM
Environmental Compliance Manager

Enclosures

"People and Technology Creating a Safer, Cleaner Environment"

HAZARDOUS WASTE FACILITY CERTIFICATE OF LIABILITY INSURANCE

1. Indian Harbor Insurance Company, the Insurer of Seaview House, 70 Seaview Avenue, Stamford, CT 06902-6040, hereby certifies that it has issued liability insurance covering bodily injury and property damage to Clean Harbors, Inc., the Insured, of 42 Longwater Drive, Norwell, MA 02061 in connection with the Insured's obligation to demonstrate financial responsibility under 40 CFR 264.147 or 265.147. The coverage applies at EPA ID# OKD 065438376 Clean Harbors Lone Mountain, LLC, 40355 S. County Road 236, Waynoka, OK 73860, for sudden and non-sudden accidental occurrences. The limits of liability are $5,000,000 each occurrence and $10,000,000 annual aggregate, exclusive of legal defense costs. The coverage is provided under policy number PEC004203906 issued on November 1, 2019. The effective date of said policy is November 1, 2019.

2. The Insurer further certifies the following with respect to the insurance described in Paragraph 1:

   (a) Bankruptcy or insolvency of the Insured shall not relieve the Insurer of its obligations under the policy.

   (b) The Insurer is liable for the payment of amounts within any deductible applicable to the policy, with a right of reimbursement by the Insured for any such payment made by the Insurer. This provision does not apply with respect to that amount of any deductible for which coverage is demonstrated as specified in 40 CFR 264.147(f) or 265.147(f).

   (c) Whenever requested by the Executive Director of the Oklahoma Department of Environmental Quality (DEQ), the Insurer agrees to furnish to the Executive Director a signed duplicate original of the policy and all endorsements.

   (d) Cancellation of the insurance, whether by the Insurer, the Insured, a parent corporation providing insurance coverage for its subsidiary, or by a firm having an insurable interest in and obtaining liability insurance on behalf of the owner or operator of the hazardous waste management facility, will be effective only upon written notice and only after the expiration of sixty (60) days after a copy of such written notice is received by the Executive Director of the Oklahoma Department of Environmental Quality (DEQ).

   (e) Any other termination of the insurance will be effective only upon written notice and only after the expiration of thirty (30) days after a copy of such written notice is received by the Executive Director of the Oklahoma Department of Environmental Quality (DEQ).

I hereby certify that the wording of this instrument is identical to the wording specified in 40 CFR 264.151(j) United States Environmental Protection Agency approved amendment, for the State of Oklahoma, as such regulation was constituted on the date first above written, and that the Insurer is licensed to transact the business of insurance, or eligible to provide insurance as an excess or surplus lines insurer, in one or more States.

(Signature of Authorized Representative of Insurer)

Date: 12-2-19

Mary Ann Susavidge, Vice President   Authorized Representative of   Indian Harbor Insurance Company

c/o AXA XL
505 Eagleview Boulevard
Suite 100
Exton, PA 19341-0636

OK-HAZWASTE (4/10)

HAZARDOUS WASTE FACILITY CERTIFICATE OF LIABILITY INSURANCE

1. Indian Harbor Insurance Company, the Insurer of Seaview House, 70 Seaview Avenue, Stamford, CT 06902-6040, hereby certifies that it has issued liability insurance covering bodily injury and property damage to Clean Harbors, Inc., the Insured, of 42 Longwater Drive, Norwell, MA 02061 in connection with the Insured's obligation to demonstrate financial responsibility under 40 CFR 264.147 or 265.147. The coverage applies at EPA ID# OK 0000070136 Clean Harbors Lone Mountain, LLC, ¼ mile East of Avard on County Road 76-22c, Avard, OK 73717, for sudden and non-sudden accidental occurrences. The limits of liability are $5,000,000 each occurrence and $10,000,000 annual aggregate, exclusive of legal defense costs. The coverage is provided under policy number PEC004203906 issued on November 1, 2019. The effective date of said policy is November 1, 2019.

2. The Insurer further certifies the following with respect to the insurance described in Paragraph 1:

   (a) Bankruptcy or insolvency of the Insured shall not relieve the Insurer of its obligations under the policy.

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(Signature of Authorized Representative of Insurer)

Date: 12-2-19

Mary Ann Susavidge, Vice President

Authorized Representative of Indian Harbor Insurance Company

c/o AXA XL
505 Eagleview Boulevard
Suite 100
Exton, PA 19341-0636

OK-HAZWASTE (4/10)

HAZARDOUS WASTE FACILITY CERTIFICATE OF LIABILITY INSURANCE

1. Indian Harbor Insurance Company, the Insurer of Seaview House, 70 Seaview Avenue, Stamford, CT 06902-6040, hereby certifies that it has issued liability insurance covering bodily injury and property damage to Clean Harbors, Inc., the Insured, of 42 Longwater Drive, Norwell, MA 02061 in connection with the Insured's obligation to demonstrate financial responsibility under 40 CFR 264.147 or 265.147. The coverage applies at EPA ID # OKD 000 632 737, Tulsa Disposal, LLC, 5354 W. 46th Street South, Tulsa, OK 74107, for sudden and non-sudden accidental occurrences. The limits of liability are $5,000,000 each occurrence and $10,000,000 annual aggregate, exclusive of legal defense costs. The coverage is provided under policy number PEC004203906 issued on November 1, 2019. The effective date of said policy is November 1, 2019.

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(Signature of Authorized Representative of Insurer) Date: 12-2-19

Mary Ann Susavidge, Vice President Authorized Representative of Indian Harbor Insurance Company

c/o AXA XL
505 Eagleview Boulevard
Suite 100
Exton, PA 19341-0636

OK-HAZWASTE (4/10)

HAZARDOUS WASTE FACILITY CERTIFICATE OF LIABILITY INSURANCE

1. Indian Harbor Insurance Company, the Insurer of Seaview House, 70 Seaview Avenue, Stamford, CT 06902-6040, hereby certifies that it has issued liability insurance covering bodily injury and property damage to Safety-Kleen Systems, Inc., the Insured, of 42 Longwater Drive, Norwell, MA 02061 in connection with the Insured's obligation to demonstrate financial responsibility under 40 CFR 264.147 or 265.147. The coverage applies at EPA ID# , SEE ATTACHED LIST, for sudden accidental occurrences. The limits of liability are $2,000,000 each occurrence and $2,000,000 annual aggregate, exclusive of legal defense costs. The coverage is provided under policy number PEC004203906 issued on November 1, 2019. The effective date of said policy is November 1, 2019.

2. The Insurer further certifies the following with respect to the insurance described in Paragraph 1:

   (a) Bankruptcy or insolvency of the Insured shall not relieve the Insurer of its obligations under the policy.

   (b) The Insurer is liable for the payment of amounts within any deductible applicable to the policy, with a right of reimbursement by the Insured for any such payment made by the Insurer. This provision does not apply with respect to that amount of any deductible for which coverage is demonstrated as specified in 40 CFR 264.147(f) or 265.147(f).

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   (d) Cancellation of the insurance, whether by the Insurer, the Insured, a parent corporation providing insurance coverage for its subsidiary, or by a firm having an insurable interest in and obtaining liability insurance on behalf of the owner or operator of the hazardous waste management facility, will be effective only upon written notice and only after the expiration of sixty (60) days after a copy of such written notice is received by the Executive Director of the Oklahoma Department of Environmental Quality (DEQ).

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I hereby certify that the wording of this instrument is identical to the wording specified in 40 CFR 264.151(j) United States Environmental Protection Agency approved amendment, for the State of Oklahoma, as such regulation was constituted on the date first above written, and that the Insurer is licensed to transact the business of insurance, or eligible to provide insurance as an excess or surplus lines insurer, in one or more States.

(Signature of Authorized Representative of Insurer)　　　　Date: 12-2-19

Mary Ann Susavidge, Vice President　　　　Authorized Representative of　　Indian Harbor Insurance Company

c/o AXA XL
505 Eagleview Boulevard
Suite 100
Exton, PA 19341-0636

OK-HAZWASTE (4/10)

SAFETY-KLEEN SYSTEMS, INC. LOCATIONS

STATE OF OKLAHOMA

7528 New Castle Road Oklahoma City, OK 73169	**OKD980878474**
26 N.E. 9th Street Oklahoma City, OK 73104	**OKD018115469**
8800 SW 8th Oklahoma City, OK 73128	**OKD987086774**
5550 E. Channel Road Port of Catoosa, OK 74015	**OKD982558207**
16319 E. Marshall Street Tulsa, OK 74116	**OKD000763821**

Harvey, Pamela

From:	Carol Bartlett <Carol.Bartlett@deq.ok.gov>
Sent:	Wednesday, November 27, 2019 2:23 PM
To:	Harvey, Pamela
Subject:	Corrections for Haz Waste Facility Certificates of Liability
Attachments:	CleanHarbor-SafetyKleen-haz-waste-certs.pdf; 40CFR151(j)-form.doc
Follow Up Flag:	Follow up
Due By:	Friday, December 06, 2019 9:00 AM
Flag Status:	Flagged

Hello Pamela:

- Per our phone conversation a few days ago, I have attached your submittal of October 30, 2019, containing the Hazardous Waste Facility Certificates of Liability Insurance.
- I'm working to get all the wording cleaned up in all of our Financial documents.
- The comments are highlighted in yellow.
- I have also attached the Hazardous Waste Facility Certificate of Liability Insurance form, with instructions at the top of the form.
    - Just in case your insurance carrier prefers a new form to work with.
    - The wording comes directly from the 40 CFR regulations, with adjustments to account for DEQ having promulgated the EPA regulations.
    - If your carrier uses the new form, please have them delete the instructions portion at the top of the form.

Please call or email me if you have any questions.

Thank you.

Carol Bartlett
Land Protection Division
Oklahoma Department of Environmental Quality
707 North Robinson, P.O. Box 1677
Oklahoma City, OK 73101-1677

(405) 702-5109
Carol.bartlett@deq.ok.gov

SECTION 3

GROUNDWATER MONITORING PROGRAM

3.1

Hydrological Setting

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3. GROUNDWATER MONITORING INFORMATION

This section of the Application provides a summary of the groundwater monitoring activities conducted at the Lone Mountain Facility from 1979 to the present. A description of recent improvements to the current detection monitoring program at the facility is also included. This section is divided into three subsections. The first subsection, Subsection 3.1 *Hydrogeologic Setting*, describes the scientific foundation from which the monitoring system is built. It characterizes the nature and occurrence of groundwater beneath the site by reducing the information obtained from the considerable volumes of both quantitative and qualitative data collected into a concise hydrogeologic conceptual model. Subsection 3.2 *Groundwater Detection Monitoring Program*, summarizes the groundwater monitoring activities performed at the site. Also included is a presentation and analysis of more than 20 years of groundwater monitoring data collected at the site. One of the intents of this Application is to summarize the information from previous investigations into one document. Data summaries, graphical presentations, and pertinent portions of previous investigations are included as Appendices to Section 3. Subsection 3.3 provides a brief summary of the Cell 5 corrective action program. Sources of information used to develop this section of the application are provided in the reference section.

3.1. HYDROGEOLOGIC SETTING

Site conditions, including the occurrence and quality of groundwater have been studied and monitored for approximately thirty years, the last 20 years of which were under the final RCRA/HSWA Permit conditions. As a result, a large amount of regional and site-specific hydrogeologic information has been compiled. Subsections 3.1.1 through 3.1.4.1 of this Application provide a concise summary of the hydrogeologic setting drawn from this information.

3.1.1. ENVIRONMENTAL SETTING

The Lone Mountain Facility is located in northwest Major County, Oklahoma. Figure 3.1: *Site Location and Topographic Map* presents a site location and topography map. The site is located in Sections 28 and 33, Township 23 North, Range 15 West, approximately five miles east and one mile north of the junction of U.S. Highways 281 and 412 on the west side of a paved county road. The permitted facility encompasses approximately 560 acres. Waynoka is the nearest town and is located on U.S. Highway 281, approximately fourteen miles northwest of the Lone Mountain Facility.

3.1.1.1. Land Use

Land use within two miles of the facility is primarily ranching with some cultivation of wheat. Due to low moisture, unproductive soil types, and rough terrain, much of the land directly adjacent to the facility is used primarily for very low-density grazing of livestock. Oil and gas wells have been installed, operated, and abandoned in the area, and there are currently several active wells in close proximity to the site. Information pertaining to the location and abandonment of oil and gas wells near the facility is presented in Appendix 3.20: *Oil and Gas Well Survey*.

3.1.1.2. Climate

The climate in the site vicinity is characterized as a semi-arid environment. The mean annual rainfall at the facility is estimated to be 25 inches/year. The estimated lake evaporation rate is 63 inches/year. May and June are normally the wettest months, while December and January are normally the driest months. High intensity, short duration rainfall events are common. Prevailing winds are from the south and south-southeast at approximate speeds of 10-25 miles per hour.

3.1.2. GEOLOGIC SETTING

The following subsections describe the geologic setting as it relates to the Groundwater Detection Monitoring Program. The discussion is presented in two parts. The first section describes geology on a regional scale perspective and the second part describes geology on a local, site wide, scale.

3.1.2.1. Regional Geology

For the purposes of this Application, the regional scale considers an area on the order of 100 square miles. The discussion of the regional geology is presented in four parts. These four parts consist of a description of regional geomorphology, regional stratigraphy, regional structural geology, and regional depositional environment.

3.1.2.1.1. Regional Geomorphology

The facility is located at the southwestern edge of the Central Lowlands province and the eastern edge of the Great Plains physiographic province. Collectively, these provinces make up the stable platform bordering the Canadian Shield and constitute the largest member of the continental structural framework. The area is characterized by relatively flat-lying formations, low altitude, and low to moderate relief.

3.1.2.1.2. Regional Stratigraphy

The primary regional geologic units encountered at shallow depths below ground surface (bgs) include the Quaternary (Pleistocene) Alluvium, Quaternary (pleistocene) Terrace Deposits, and sedimentary rocks of the Cimarronian Series. Figure 3.2: *Regional Geologic Map* is a geologic map of the region. Figure 3.3: *Conceptual Regional Geologic Cross-Section* shows a conceptual regional geologic cross-section for the region, and Figure 3.4*: Stratigraphic Column* represents a generalized regional stratigraphic column.

Alluvial sediments consisting of sand, gravel, and silt deposits of Quaternary age occur along the stream valleys and drainages 2000 feet east of the facility and along the Cimarron River to the north. The Quaternary Alluvium ranges from 20 to 100 feet thick. Extensive alluvial terrace deposits occur on the north side of the Cimarron River, covered locally by sand dunes derived from wind transport of the alluvial terrace deposits.

Underlying the Quaternary Alluvium are slightly older Quaternary Terrace deposits. These deposits consist of gravel, sand, silt, and clay ranging in thickness from 60 to 150 feet. They are relatively flat lying and occur on eroded portions of the Permian Flowerpot Shale east and north of the facility, on the north side of the Cimarron River.

The Cimarronian Series includes the El Reno and Hennessey Groups. The El Reno Group is approximately 700 feet thick and comprises the Permian Cedar Hills Sandstone (up to 180 feet thick), the Flowerpot Shale (180 feet to 430 feet thick, with middle Chickasha wedge 30 feet thick), the Blaine Formation (up to 90 feet of dolomite, gypsum, and shale), and the overlying Dog Creek

Shale (30-100 feet thick) (Figure 3.4). The Dog Creek Shale is absent at the site. The Hennessey Group consists of four units in ascending order: the Fairmont Shale, the Kingman Formation, Salt Plains Formation, and the Bison Shale (Morton, 1980). The Fairmont Shale is approximately 160 feet thick and is composed of red-brown clayey shale with some thin green-gray siltstone layers less than a few inches in thickness. The Kingman Formation is approximately 70 feet thick and consists of fine-grained sandstone and siltstone. The Salt Plains Formation also consists of fine-grained sandstone and siltstone and is up to 160 feet thick. The Bison Shale is approximately 120 feet thick and is composed of red-brown shale with many green-gray siltstone and sandstone beds up to four feet in thickness. The total thickness of the Hennessey Group in Blaine County is approximately 600 feet.

The Permian Blaine Formation forms the caprock on the southwestern and western portions of the site (Figure 3.3). The Blaine Formation consists primarily of interbedded gypsum and shale beds with occasional thin dolomite layers (Fay, 1964). At the site, the formation is primarily a massive gypsum unit. The primary minerals found in the Blaine Formation include gypsum, dolomite, anhydrite, illite, and quartz, with local concentrations of boron, strontium, and copper (Fay, 1964; Ham et al, 1961). Thick weather-resistant gypsum beds of the Blaine Formation overlie the Flowerpot Shale and cap the ridges in the area.

The Flowerpot Shale underlies the Blaine formation in the region. It is a primary unit of interest in the area because it directly underlies the site. Regionally, the Flowerpot Shale consists of reddish-brown and greenish-gray silty claystone with thin layers of gypsum, dolomite, and very fine-grained sandstone.

As defined in this Application, the Cedar Hills Sandstone is located at the base of the Cimarronian Series (Morton, 1980). The Cedar Hills Sandstone in northwestern Oklahoma contains thin sandstone and siltstone layers in the upper portion (Fay 1962, 1964, 1965). The formation consists of brownish red, fine-grained sandstones and sandy siltstones separated by beds of silty shale and argillaceous siltstone in the type region in Kansas. In the upper 105 feet, the Cedar Hills Sandstone is primarily a reddish-brown silty shale with several prominent interbedded light greenish-gray siltstones.

3.1.2.1.3. Regional Structural Geology

The site is located on the eastern edge of the Anadarko Basin which extends across western Oklahoma trending in a northwest to southeast direction. Regionally, geologic units dip gently to the southwest at approximately 17 feet per mile, or a 0.2 degree slope (Morton, 1980).

LANDSAT images were examined for linear features that could indicate structural controls for groundwater movement in bedrock at the Lone Mountain Facility. The LANDSAT image lineament interpretation was performed from multispectral scanner imagery (MSS imagery) by the Oklahoma State University Remote Sensing Center in 1987. The MSS data for the image was gathered on September 11, 1979, before the facility had expanded northward to its present position (scene ID 821169316293XO). The interpreted coverage encompasses an area of 3 to 4 miles in all directions around the facility in Section 33, T23N, R15W. The digital data has a ground resolution of 1.1 acre (57 meters by 79 meters). The linear features were enhanced by spectral band ratioing using bands 7 and 2, computing the mean of four spectral bands, high-pass band filtering, and contrast stretching.

The LANDSAT image enhancements revealed a predominant set of northeast-southwest lineaments and a secondary west-northwest lineament pattern. The spacing of the northeast-southwest lineaments typically ranges from 1 per ½-mile to 1 per ¾ -mile. Two of the northeast lineaments and one northwest lineament pass through Section 33. Three of the northeast-southwest lineaments pass through Section 28. Because of the one-acre ground resolution, the exact cause of the lineaments on the digital image is uncertain. The configuration of some of the mesa-like hills and the accompanying drainage patterns observed on the topographic map suggest that the digital enhancements have detected alignments of steep hill slopes and streams on the upper units of the Flowerpot Shale and the lower beds comprising the overlying Blaine Formation. The presence and direction of these features could be controlled, in part, by preferred erosion along brittle structural breaks such as joints and faults. The results of this LANDSAT lineament analysis are presented in full in Appendix 3.1: *Lineament Analysis*.

3.1.2.1.4. Regional Depositional Environment

As mentioned previously, the Flowerpot Shale is the principal unit of interest in the area because it directly underlies the site and the surrounding area. The following discussion on the depositional environment of the Flowerpot Shale is based on R.O. Fay's "Geology of Blaine County", Oklahoma Geological Survey Bulletin 98, 1964.

The predominant lithologic unit in the formation is a reddish-brown shale (claystone). Within this formation, clay was deposited in three depositional environments on the eastern flank of the Anadarko Basin. These environments are defined as the northern platform, the central basin, and the southern, or Tussey delta.

The Flowerpot Shale northern platform environment extends from northern Major County northward into Kansas. Sediments in this environment were deposited in a shallow, marginal marine shelf environment. Freshwater streams transported fine-grained sand, silt, and clay from the Ozark Uplift to the east into the marginal marine shelf. The upper part of the Flowerpot Shale is siltstone and dolomite which attained maximum development in Major and Woodward Counties, Oklahoma. These lithologic units thin northward and southward and evidently grade westward into shales of the Permian basin.

The Flowerpot Shale central basin environment extends from northern Blaine County to northern Grady County, Oklahoma. The sediment in this environment was deposited in a subsiding basin. Dolomite and siltstone of the northern platform are absent in the central basin facies, where they grade into reddish brown gypsiferous clay shale (claystone). The lithologic units are generally thicker in the basin than on the northern platform. It is therefore likely that the bottom of the sea was subsiding in the basin during deposition and that more sediment was being received in this area relative to the surrounding depositional environments.

The Flowerpot Shale southern delta environment consists of deposits of fine silt and mud, with an overall increasing amount of sand to the south and southeast within the Anadarko Basin. This indicates that the southern delta deposits were probably derived from erosion of the Arbuckle Mountains area rather than the Ozark Uplift to the north. As a result of the influx of freshwater, which would have lowered the salinity within the depositional environment, evaporite units of the central basin facies are absent in the deltaic facies.

3.1.2.2. Site Geology

The site scale, in this Application, refers to the environment within and immediately adjacent to the aerial footprint of the facility. The following discussion of the site geology is divided into geomorphology, stratigraphy, structural geology, and lithological analysis.

3.1.2.2.1. Site Geomorphology

The facility is located near the boundary of the Cimarron Gypsum Hills (southwest of the facility) and the Central Red Bed Plains (northeast of the facility; Johnson, et al. 1979). The Cimarron Gypsum Hills consist of escarpments and badlands developed on a Permian sequence of interbedded gypsum and shale. The Central Red Bed Plains consist of red Permian shales and sandstones forming gently rolling hills and broad, flat plains.

The topography of the site is controlled by resistant gypsum beds (Blaine Formation). These beds cap the highlands forming box canyons, buttes, mesas, and steep sided ridges that have a topographic relief of approximately 300 feet. Elevations range from approximately 1360 to 1440 feet above mean sea level (amsl) across most of the facility. However, topography near the southwest edge of the facility rises abruptly to elevations of 1600 feet or more (Figure 3.1).

The facility is located in the Arkansas River drainage basin, of which the Cimarron River is a tributary. The Cimarron River is located approximately 1.5 miles northeast of the facility (Figure 3.1). Griever Creek is an intermittent watercourse located 1 mile southeast of the facility that drains to the northeast into the Cimarron River.

3.1.2.2.2. Site Stratigraphy

The characterization presented in this subsection focuses on the two primary lithologic units that lay immediately beneath the facility; the Flowerpot Shale and the Cedar Hills Sandstone. The Blaine Formation overlying the Flowerpot Shale is located, when present, at elevations above the facility structures and operations. A generalized stratigraphic column for the site is presented as Figure 3.4.

Surficial soils at the site are derived from the Flowerpot Shale and Blaine Formation. These soils include the Vernon Badland Complex and the Vernon Clay Loam. In some areas, these soils generally consist of a reddish-brown surface layer about 6 inches thick overlying a clay loam subsoil which grades into a claystone at a depth of up to 16 inches (bgs). Due to their clay content, these soils generally have a rapid runoff and low permeability (Allgood, 1968).

The Flowerpot Shale, which directly underlies the site, outcrops in the lowlands and steep-sided ridges within the facility boundary. It extends to a depth of approximately 350 feet (bgs). The Flowerpot Shale consists of relatively homogeneous, firm to incompetent claystone, although variations in color and texture are observed. The unit is primarily reddish-brown in color with interbedded green layers. The green claystone layers are a different lithofacies than the red claystone. The red claystone layers are generally thicker than the green claystone layers. The green claystone layers have been used as structural and stratigraphic marker beds for subsurface mapping and correlation purposes. Due to the relatively high density of soil boring information available, the stratigraphy in the Cell 5 area has been examined more than any other area within the site. The stratigraphy in the Cell 5 area is generally thought to be largely representative of the stratigraphy throughout the site.

Appendix 3.2: *Soil Boring and Monitoring Well Geologic Logs* contains the available geologic logs from the soil borings and monitoring wells constructed at the facility. Although the majority of the borings were relatively shallow, there were several which were drilled to depths greater than 100 feet and two that were drilled to depths of greater than 400 feet (into the Cedar Hills Sandstone). Information from all of these geologic logs and available well construction data (where appropriate) was assembled into a national database. Information contained in this database was used to construct a detailed 3-dimensional stratigraphic model.

A detailed analysis of all available subsurface boring information was conducted to generate this three-dimensional, site-specific, stratigraphic model of the shallow subsurface. A detailed examination of the geologic logs resulted in identification of distinctive marker facies, consisting mainly of red and green claystone layers within the Flowerpot Shale, which could be correlated and mapped in the subsurface beneath the site. A total of 31 geologic units were identified from the top of the surrounding buttes and mesas (Blaine Formation) to the Cedar Hills Sandstone, with geologic unit number 1 being the youngest unit and number 31 being the oldest. Increasing unit number is also inversely proportional to elevation. A detailed site stratigraphy based on a correlation of the green claystone layers within the Flowerpot Shale is shown on Figure 3.12. Geologic Unit 23, previously called the First Green Claystone in the Cell 5 RCRA Facility Investigation (USPCI, 1994, 1995 and 1996) can be traced throughout the site. The stratigraphic model facilitated the construction of fence diagrams and cross-sections for the site and surrounding area. Figure 3.5: *Site Fence Diagram* is a fence diagram of the stratigraphy under the facility, and Figures 3.6: *North-South Cross Section A-A′* and 3.7: *East-West Cross-Section B-B′* are cross-sections in the north-south and east-west directions at the facility, respectively.

3.1.2.2.3. Site Structural Geology

No major geologic structural features are known to exist either regionally or in the immediate vicinity of the site. Bedding attitudes measured in outcrops at the site average 16.4 feet per 1,000 feet (87 ft/mile), or a 1.0 degree slope with dip towards the southwest (USPCI, 1987).

Aerial photographs were examined for linear features that could indicate structural controls for groundwater movement in bedrock at the facility. In 1995-1996, Laidlaw Environmental Services, Inc., Consulting Services Group (formerly USPCI) stereoscopically examined two sets of black and white aerial photographs covering the facility and surrounding area. Bedrock linear features were mapped as directly observed from the aerial scenes, and as interpreted from geomorphic features observed that are indicative of fault and joint controls of erosion and weathering. The scale of one set of photos collected on February 6, 1988 is 1:6,000 (1 inch = 500 feet); the scale of the other set of photos collected on April 22, 1993 is approximately 1:4,600. The older set covers a broader area in partial stereoscopic view. All photo resolution is good, and cloud cover is minimal.

The more resistant beds of the Blaine Formation and the Flowerpot Shale typically form the caprock for all the mesas, buttes, and ledges around the facility. The stereoscopic view confirms the gentle southwest dip of the formation. Northeast and north-northeast trending joints can be directly discerned in the capping beds of the hilltops. The erosion of the underlying Flowerpot Shale beds and the direction of stream drainages also reveal a predominant northeast trending pattern. A secondary direction of jointing and significant erosional alignments also trends to the northwest and west northwest. Some of these structures may be due to regional tectonics and others may simply be unloading phenomena. Tectonic fault offsets were not observed.

Small scale (on the order of inches to a few feet) secondary permeability structures occur within the Flowerpot Shale. The structures observed at the site are often infilled with gypsum. These types of structures are commonly found in fine-grained sedimentary rock. They can develop during sedimentation or shortly after.

3.1.2.2.4. Site Lithological Analysis

Two different studies focusing primarily on the Flowerpot Shale have been conducted by the Lone Mountain Facility regarding whole-rock analysis of the formations beneath the site. These include:

1. An X-ray diffraction analysis on eight core samples from boring LB3 in the Flowerpot Shale. This analysis was performed by Core Laboratories in 1987. In addition to the eight x-ray analyses, four additional samples from up-gradient test borings 1, 3, 4, and 6 were analyzed to assess whole rock mineralogy.

2. A whole-rock elemental analysis of twenty-four core samples was conducted by National Analytical Laboratories (NAL) in 1987. The twenty-four samples were randomly selected from up-gradient wells (TB-1, 2, 3, 4, 6, and 14).

A summary regarding the results of these investigations is provided below. The results of the investigations in full are presented in Appendix 3.3: *Lithological Analysis*.

X-Ray Analysis - Core Laboratories. X-ray diffraction analysis was conducted on eight claystone core samples from boring LB3. The results of the analyses are summarized in Table 2 of Appendix 3.3. Sample depths ranged from 24 to 82 feet (bgs). Illite was the predominant clay mineral present; ranging from 11% to 56% of total material. Quartz was the predominant non-clay mineral; present at 25% to 53%. Minor mineral constituents present included calcium and potassium feldspars, mixed layer clays, ferroan carbonate, gypsum, and calcite.

Whole-Rock Mineralogy - Core Laboratories. Four samples from up-gradient test borings 1, 3, 4, and 6 were analyzed to assess whole rock mineralogy. This data is summarized in Table 1 of Appendix 3.3. The results of this analysis are similar to the x-ray diffraction results discussed above; a predominance of quartz and illite minerals exist in the rock. The percentage of silt was also estimated in the samples based on visual observations of thin sections. The samples were primarily clay with very little silt present (ranging from 1-6%). Visual analysis of core samples from soil borings revealed that within the

Flowerpot Shale, gypsum most commonly occurs as veinlets less than 0.1 foot thick (USPCI, 1987). These veinlets may be infilled secondary permeability structures (USPCI, 1994).

Elemental Analysis - National Analytical Laboratories. Twenty-four core samples were randomly collected from up-gradient test borings 1, 2, 3, 4, 6, and 14. Samples were collected from a wide range of depths of 31 to 393 feet (bgs). The compounds detected in this analysis are summarized in Table 3 of Appendix 3.3. A graphical summary of the data is also presented in Figures 1 and 2 of Appendix 3.3. Eighteen metals (aluminum, arsenic, barium, beryllium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, sodium, vanadium, and zinc) as well as fluoride, chloride, and sulfate were detected in the samples. The dominant components, based on concentration, were aluminum, calcium, iron, magnesium, potassium, sodium, chloride, and sulfate. These components, in addition to silicon and oxygen, are the primary constituents of the clay minerals of the Flowerpot Shale: illites, chlorites, and smectites. However, it should be noted that metals of environmental concern such as arsenic, chromium, lead, and mercury were also present in the bedrock material up-gradient of the facility (USPCI, 1987).

3.1.3. HYDROLOGIC SETTING

Similar to Subsection 3.1.2, this Subsection is presented in two parts; regional hydrology and site hydrology. For the purposes of this Application, the differentiation between regional groundwater and site groundwater is not only aerial but is also differentiated stratigraphically.

3.1.3.1. Regional Hydrology

The discussion of the regional hydrology is subdivided into four Subsections; regional groundwater use and occurrence, regional water-bearing unit characterization, regional groundwater flow, and regional hydrogeochemistry.

3.1.3.1.1. Regional Groundwater Use and Occurrence

Due to generally poor surface water quality, water users in the region rely on groundwater as the primary water source. Groundwater use is primarily for irrigation, while most of the remainder is used for municipal supply and livestock.

The Quaternary Alluvial deposits, Quaternary Terrace deposits, and the Cedar Hills Sandstone are the chief water-bearing units of interest in the area immediately surrounding the facility. The Permian Blaine Formation and Permian Flowerpot Shale are surface or near-surface, gypsum-rich units that are not used for water supply at or immediately surrounding the facility because of their poor quality and water yields.

The most significant sources of groundwater are found in formations ranging in age from Quaternary to Permian. In order of increasing age or depth, the following units are capable of significant groundwater production in the area surrounding the facility: Quaternary Alluvium or Channel Sands and Gravels; Quaternary Terrace Deposits; and the Permian Cedar Hills Sandstone. A stratigraphic section showing the chief water producing units and other water-bearing units is shown in Figure 3.8: *Regional Water-Bearing Units in the Vicinity of Lone Mountain Facility*. The depth to groundwater varies from thirty to several hundred feet (bgs), depending on location and the specific formation.

One-hundred sixteen (116) groundwater water wells have been identified within a 7.5 mile radius of the facility (Oklahoma Water Resources Board, 2009). A complete list of these wells is provided as Table 3.1: *Water Supply Wells within a 7.5mile radius of the Lone Mountain Facility* and the location of these wells is shown in Figure 3.9: *Regional Water Well Location Map*. Wells are divided into four quadrants (Northeast, Northwest, Southeast, and Southwest) relative to the facility.

3.1.3.1.2. Regional Water-Bearing Unit Characterization

The water-bearing units in the region are those shown in Figure 3.8: *Regional Water-Bearing Units in the Vicinity of Lone Mountain Facility*. These units include the Quaternary (Pleistocene) Alluvium, Quaternary (Pleistocene) Terrace Deposits, Permian Flowerpot Shale, and the Permian Cedar Hills Sandstone. The hydrological properties of these water-bearing units surrounding the facility are listed in Table 3.2: *Hydrological Properties of Water-Bearing Units*.

The Quaternary (Pleistocene) Alluvium, the youngest aquifer found in the region, consists of sand, gravel, and silt deposits along stream valleys. It ranges in thickness from 20 to 100 feet. These deposits occur within one mile southeast of the facility along Griever Creek and one mile north along the Cimarron River.

Quaternary (Pleistocene) Terrace Deposits, which are slightly older than the Alluvium, consist of gravel, sand, silt, and clay 60 to 150 feet thick. These Terrace Deposits occur two miles northeast of the facility on the north side of the Cimarron River (Morton, 1980). Both Alluvium and Terrace Deposits are relatively flat-lying and occur on eroded portions of the Permian Flowerpot Shale to the east and north of the facility.

The Flowerpot Shale dips very gently towards the southwest, but near-surface groundwater flow is northeast toward the Cimarron River in the region surrounding the facility (USPCI, 1987). The Flowerpot Shale is not a significant source for groundwater in the region.

The Permian Cedar Hills Sandstone underlies the Flowerpot Shale. It dips very gently to the southwest, but groundwater flow is toward the northeast in the region surrounding the facility (USPCI, Sept. 1994, Cell 5 RFI Phase II Report, Vol. 1). The Cedar Hills Sandstone is a confined water-bearing unit with the overlying Flowerpot Shale serving as the confining layer.

Recharge is accomplished by rainfall on outcrop areas of the Quaternary Alluvium and Terrace Deposits, the Permian Blaine Formation, the Permian Flowerpot Shale, and the Permian Cedar Hills Sandstone. These outcrop areas occur throughout the region for the Alluvium, Terrace Deposits, Blaine Formation, and Flowerpot Shale, as shown in the Regional Geologic Map (Figure 3.2). The recharge area for the Cedar Hills Sandstone extends generally southeasterly from an area northeast of the terrace deposits (that are north of the Cimarron River) to an area in the Cimarron River Valley approximately 15-25 miles east of the facility. Regionally, groundwater derived from local precipitation moves toward ephemeral streams that intercept or nearly intercept the water table, where much of the water is likely discharged by evapotranspiration. Groundwater discharge to the surface may not be apparent near these streams, except as accumulated salts on the surface that are periodically flushed from channels by stormwater runoff.

3.1.3.1.3. Regional Groundwater Flow

The direction of groundwater flow in the region is depicted in Figure 3.10: *Regional Groundwater Flow Diagram*. The regional flow regime is controlled by processes across the entire Anadarko Basin (USPCI, 1995). Topographically low areas, such as the Cimarron River Valley, are typically areas of groundwater discharge for regional flow systems. The inferred direction of groundwater flow in the regional flow regime is vertically upward and horizontally in a northeasterly direction (USPCI, 1991, 1994). The potentiometric surface in the Cedar Hills Sandstone wells is higher than the potentiometric surface in Flowerpot Shale wells, indicating an upward vertical hydraulic gradient.

3.1.3.1.4. Regional Hydrogeochemistry

The regional hydrogeochemistry is relatively complex. Much of the groundwater is saline, particularly within the Flowerpot Shale, and exceeds seawater in total dissolved solids (TDS). Figure 3.11: *Regional Geochemistry Map* graphically illustrates regional groundwater geochemistry data using Stiff Diagrams as provided by the USGS (USGS, 2009). The relative shape of the Stiff Diagrams illustrates the dominant anions/cations in the groundwater in each formation. Although the USGS data is incomplete, the USGS data which is available is consistent with data presented by Morton (Morton, 1980) and USPCI (USPCI, 1987). Based on this data, the water quality of the major regional water-bearing units is summarized below:

• The Alluvium groundwater is sulfate-rich and has very high TDS values ranging from 684 mg/L to 7140 mg/L with a median of 2860 mg/L (Morton, 1980).
• The Terrace Deposits probably have the best quality groundwater in the region with a median TDS value of 357 mg/L (Morton, 1980).
• The water in the Flowerpot Shale is very high in TDS with values ranging from 3000 to 91000 mg/L (USPCI, 1987). The water in the upper pan of the Flowerpot is more sulfate-rich, while the water in the lower portion is chloride-rich (USPCI, 1991).
• The Cedar Hills Sandstone water has relatively low TDS values which range from 387 to 3660 *mg/L* with a median of 954 *mg/L*. Nearly equal amounts of sulfate and chloride are found in the Cedar Hills Sandstone (Morton, 1980).

3.1.3.2. Site Hydrology

This subsection presents a hydrologic characterization of the water-bearing units found in the shallow subsurface beneath the site. The Flowerpot Shale lies immediately beneath the site and is very thick [it extends more than 300 feet (bgs)]; therefore, the focus of this hydrologic characterization will be on the water-bearing units within this formation. The site hydrology is presented in two parts: site water bearing unit characterization and the site hydrogeochemistry. The site water-bearing unit characterization description has been further subdivided into hydrological properties summary, local groundwater systems, and summary of hydrogeologic field tests.

3.1.3.2.1. Site Water-Bearing Unit Characterization

Groundwater flow in the shallowest Flowerpot Shale water-bearing facies beneath the site is controlled by local topographic relief and local recharge. This groundwater flow zone is here-in-after referred to as the "local flow regime". Groundwater that is likely traveling along regionally controlled f1ow paths is characterized as being in the "regional flow regime".

Results from detailed examinations performed in the subsurface near Cell 5. (USPCI 1994, 1995, and 1996) indicate that, in general, a thick relative aquitard (i.e., in relationship to the permeabilities of the porous media adjacent to the unit) acts to segregate the local and regional flow regimes. This relative aquitard was called the "First Green Claystone" in the Cell 5 RCRA Facility Investigation (USPCl 1994, 1995, and 1996) and is termed Geologic Unit 23 in the stratigraphic model presented in this Application (Subsection 3.1.2.2.2, Site Stratigraphy). This facies is found at elevations of 1365 to 1370 feet (amsl). This relative aquitard strongly inhibits the transmission of groundwater between the local groundwater flow regime and the regional groundwater flow regime.

The hydrogeochemical signature of groundwater can be used to evaluate whether the groundwater is part of a regional or local flow regime. Groundwater within a regional flow regime is older and has been in the subsurface longer than groundwater within the local flow regime. As a result, it has a hydrogeochemical signature (i.e., characteristic makeup) that reflects a state of chemical equilibrium with surrounding porous media. In the case of the gypsiferous nature of the local Flowerpot Shale, the groundwater becomes saturated with constituents like sodium and chloride. The specific conductance (a measurement similar to TDS) of groundwater in the regional flow regime can be many times that of sea water (USPCI, 1996). Groundwater within the local flow regime will not have completely equilibrated with the surrounding porous media. Therefore, the specific conductance of this groundwater will be significantly less than groundwater from the regional flow regime.

A three-dimensional model was developed for the site groundwater. The thirty-one (31) geologic units of the sitewide stratigraphic classification system (Section 3.1.2.2.2, Site Stratigraphy) are grouped into two different hydrogeologic flow units: the local groundwater flow regime and the regional groundwater flow regime. A depiction of the hydrogeologic classification is shown in Figure 3.12: *Site Water-Bearing Unit Description*.

3.1.3.2.1.1. Hydrological Properties Summary

The physical, hydraulic, and structural properties described below provide important controls to the lateral migration of groundwater on the site.

Hydrometer analysis of claystone samples collected from the site indicates that the Flowerpot Shale is composed of clay and silt size particles. Flowerpot Shale samples exhibit liquid limits ranging from 37 to 50, plastic limits ranging from 19 to 25, and a plastic index ranging from 18 to 25. The specific gravity ranges from 2.722 to 2.783. The porosity ranges from 0.31 to 0.372 (Fugro-McClelland, 1994).

The thick red claystones of the Flowerpot Shale yield generally less than one gallon per minute (gpm) of groundwater and have a primary matrix permeability which averages approximately 10-6 cm/sec [based on packer test, pump test, and slug test results, (USPCI, 1994)]. Testing also indicates that the horizontal permeability of the claystone is approximately two orders of magnitude greater than the vertical permeability. The thinner green claystones generally have a permeability two orders of magnitude lower than the red claystones. Observational data indicates that the green claystone lithofacies inhibit vertical groundwater flow. The vertical hydraulic conductivity of the First Green Claystone is approximately 10^{-8} cm/sec (USPCI, 1994).

Secondary permeability structures, in the form of veins and veinlets, have been observed within the red claystone underlying the site (USPCI, 1994). Most observed secondary permeability structures were at least partially infilled with gypsum. The size, number, and distribution of these structures vary widely across the site. The degree of gypsum filling of a vein or veinlet may cause zones of increased or decreased permeability within a lithologic unit and will typically influence capacity to transmit groundwater through that unit. Although some secondary permeability features were observed in Geologic Unit 23 (First Green Claystone layer), they were less common than those observed in Geologic Unit 22, termed the Upper Red Claystone in the Cell 5 area (USPCI, 1994). Field observations indicate the green claystone is more plastic and able to deform when stressed (USPCI, 1994).

A frequency analysis of the distribution of veinlets in Test Borings 1 through 15 was conducted by the facility as part of the original permitting activities. The analysis concluded that the frequency of the gypsum veins and veinlets was random. A copy of this analysis is provided in Appendix 3.4: *Claystone Veinlet Frequency Analysis*. Local areas of gypsum dissolution have been observed in some veinlets, enhancing local transmissivity. The zones of interconnected secondary permeability are relatively small. Qualitative observations of boring logs indicate there is generally a greater number and frequency of secondary structures near the surface and that the number and frequency of the secondary structures decreases with depth. This suggests that any groundwater flow within the secondary structures is more prevalent at shallow depths than at greater depths.

3.1.3.2.1.2. Local Groundwater Systems

Water level measurements in the upper part of the Flowerpot Shale at the facility indicate that groundwater is flowing northeastward from elevated recharge areas to the southwest toward the Cimarron River. Some localized exceptions likely occur due to topography, recharge locations, and mounded groundwater conditions. Hydraulic gradients estimated from potentiometric surfaces for the local flow regime range from 0.009 to 0.091. In general, the direction of groundwater flow in both the local and regional regimes is from southwest to northeast. The flow patterns for both regimes are illustrated in Figure 3.10: *Regional Groundwater Flow Diagram*. Detailed potentiometric surface maps for the local flow regime for the years 2009 through 2019 (one per year) at the facility are provided in Appendix 3.5: *Potentiometric Maps of Upper Unconfined Water-Bearing Unit (2009-2019)*. Water level data from the site indicate that a slight vertical downward gradient exists within the upper 80 feet of the Flowerpot Shale and there is a horizontal gradient from southwest to northeast (USPCI, 1994). The groundwater flow rate in the local flow regime is controlled by both primary and secondary permeability within the red claystone. The hydraulic conductivity of the typical claystone matrix is very low; however, local zones of increased permeability are present due to the occurrence of secondary structural features (discussed in the preceding section and Section 3.1.2.2.3, Site Structural Geology).

Recharge to the local flow regime within the Flowerpot Shale occurs along the gypsum caprock mesa at the highest elevations both on and west of the site. Precipitation can pool in pockets within the Blaine Formation capping the mesa until it slowly infiltrates into the subsurface or evaporates. The local flow regime can discharge at the ground surface through evapo-transpiration. Geologic Unit 23 (First Green Claystone layer) is the facies that segregates the local flow regime from the regional flow regime on the facility property. The outcrop of this unit is the down-gradient extent of the local flow regime. Some groundwater from the regional flow regime daylights between the eastern boundary of the facility and the Cimarron River. That groundwater is eventually evapo-transpired to the atmosphere.

3.1.3.2.1.3. Summary of Hydrogeologic Field Tests

The hydrogeologic properties of the Flowerpot Shale beneath the site have been examined using numerous techniques including: slug tests, tracer tests, packer tests, groundwater recovery tests, laboratory tests, pump tests, and Volan computer analysis of borehole geophysical logs. The results of these tests for the water-bearing facies within the Flowerpot Shale are summarized in the following paragraphs and are attached in full as appendices. Hydraulic conductivities determined by various methods are summarized in Table 3.3: *Hydraulic Conductivity Values Summary Field Testing of Water-Bearing Units*.

<u>Slug Tests</u>

Slug tests performed in wells LB-1B, LB-1A, and LB-3A indicated hydraulic conductivity values ranging from 5.3×10^{-6} to 2.1×10^{-6} cm/sec for the Flowerpot Shale, using a method described by Cooper, Bredehoft, and Papadopolus (1967) (USPCI, 1987; USPCI, 1988). In-situ slug tests were performed in several monitoring wells prior to their abandonment. Type curves developed by Cooper, Bredehoft and Papadopolus (1973) were used to calculate hydraulic conductivities in these wells (USPCI, 1988). These slug tests results are summarized in Table 3.3: *Hydraulic Conductivity Values Summary Field Testing of Water-Bearing Units*, and Appendix 3.6: *Slug Test Results* contains the complete slug test results.

<u>Tracer Tests</u>

A bromide tracer test was performed at borings HLB-4 and LB-3 in 1984 and 1985. These results are included in Appendix 3.7: *Tracer Test Results*. Darcy velocity between these borings ranged from 4.52 x 10^{-4} cm/sec to 4.94 x 10^{-4} cm/sec, which is much higher than expected. These anomalously high groundwater velocities indicate the presence of natural or induced secondary permeability features in the Flowerpot Shale at this location (USPCI, 1987).

Tracer tests were also performed at a series of well nests TNA A, B, C, and D. These results are included in Appendix 3.7. Each source well in each nest was spiked with 2.5 kg of potassium bromide, and 5.0 kg of potassium iodide was also added to the shallower tracer well in each test. Iodide and bromide compounds were used because neither is a major constituent of the groundwater or the native rock. Receptor wells in each nest were arranged approximately along a down-gradient arc at a distance of 5 feet from each source well. The results of this series of tests were inconclusive (USPCI, 1987).

Packer Tests

Packer tests were performed in most of the test borings drilled up to 1987. The packer test is based on a principle similar to that of the laboratory falling head permeability test. A gradient is established by total head (water column and pressure head) above the water table distributed over the length of the test interval. The packer test computations are based on those reported on pages 576-578 in the Earth Manual (U.S. Bureau of Reclamation, 1974) and results are summarized in Table 3.3. Average packer test results are as follows: 1.62 x 10^{-5} cm/sec for the upper unconfined aquifer, 5.69 x 10^{-6} cm/sec for the upper unconfined aquitard, 3.10 x 10^{-6} cm/sec for the upper unconfined aquiclude, 3.35 x 10^{-6} cm/sec for the upper confined aquifer, 1.9 x 10^{-5} cm/sec for the upper confined aquitard. (Note: This terminology is no longer being applied to the site stratigraphy. Refer to Figure 3.12: *Site Water-Bearing Unit Description* for a cross-reference of this terminology with current terminology and hydrogeologic units for the site.)

In 1994, a total of 8 packer tests were conducted in core holes PT-1 and PT-2 by USPCI and its contractor, Golder Associates. These packer tests evaluated the in-situ hydraulic conductivity of the Flowerpot Shale down-gradient of Cell 5. The selected test intervals in the Flowerpot Shale included the Upper Red Claystone, First Green Claystone, Lower Red Claystone, and the red claystone at the bottoms of the borings. Hydrologic packer testing was performed using a downhole straddle packer assembly with associated surface equipment. The constant head test analysis indicated hydraulic conductivity ranges from 4.1 x 10^{-7} cm/s to 6.7 x 10^{-6} cm/s. One test interval (PT-2; Test 4) was analyzed using a slug decay analysis and yielded a hydraulic conductivity value of 4.0 x 10^{-8} cm/s. Packer test results suggest that the Flowerpot Shale near Cell 5 exhibits low primary permeability and that secondary permeability features were not present in PT-l and PT-2 (USPCI, 1994).

All of the above-referenced packer test results are included as Appendix 3.8: *Packer Test Results*.

Borehole Groundwater Recovery Rates

Boreholes used for the collection of grab groundwater samples during the Cell 5 RFI were also used for measurement of groundwater recovery rates (USPCI, 1994). This data is included as Appendix 3.9: *Borehole Groundwater Recovery Rate Results*. Groundwater recovery rate data provides a qualitative means to detect and evaluate spatial variations in hydraulic conductivity beneath the site. These data are approximate and are valid only for screening purposes. Following drilling of a given interval, groundwater samples were generally collected as soon as a sufficient volume of groundwater had accumulated. The time elapsed between completion of drilling and sample collection was recorded on field logs. This "recovery" time value approximately represents the rate at which the borehole produced groundwater. The actual rate of groundwater recovery in a given borehole interval is partially related to the hydraulic conductivity of that interval. Other borehole effects could influence recovery time. The variability in recovery rates suggests that hydraulic conductivity of the area could be affected by secondary structures such as veins or veinlets (USPCI, 1994).

Laboratory Geotechnical Tests

Core samples were randomly selected from packer test intervals for geotechnical testing by Core Laboratories in Tulsa, Oklahoma as part of the original permitting hydrogeologic investigation at the facility. Hydraulic conductivity, total porosity, and bulk density were measured from selected cores. Both horizontal and vertical hydraulic conductivity were determined in the samples. Horizontal hydraulic conductivities were generally 1 or 2 orders of magnitude greater than vertical hydraulic conductivities. Procedures and results are presented in full in Appendix 3.10: *Geotechnical Laboratory Test Results* and are summarized in Table 3.3.

Aquifer Pump Tests

Several aquifer pump tests have been conducted at the facility over its history. Results from these investigations are summarized in Table 3.3 and are attached as Appendix 3.11: *Pump Test Results*.

Again, please note that the terminology used in the correlating report is no longer being applied to the site stratigraphy. Refer to Figure 3.12: *Site Water-Bearing Unit Description* for a cross-reference of this terminology with current terminology and hydrogeologic units for the site.

Aquifer pump tests were conducted on wells screened in the regional flow regime (wells MW CH-C and MW CH-D) as pan of the original permitting hydrogeologic investigations at the facility (USPCI. 1988). Tests were performed on February 18, 1988 with MW CH-D as the pumping well and MW CH-C as the observation well. The methods used to analyze these pump test data include the (1) Jacob Method, (2) Theis Method, and (3) the Hantush-Jacob Method. These methods are described in detail in Groundwater Hydraulics by Lohman (1979) (USPCI. 1987). The average hydraulic conductivity was calculated to be 6.36 x 10^{-6} cm/sec for the regional flow regime in the Flowerpot Shale.

Two aquifer tests were performed in 1995 in the upper portion of the Flowerpot Shale near Cell 5. The first test was conducted to qualitatively assess the hydraulic connection between the local and regional flow regimes near well RFI-16 (USPCI. 1995). A hydraulic connection was suspected based on tetrachloroethylene (PCE) detections in wells screened in Geologic Unit 24 (Lower Red Claystone). A 48-hour pump test was conducted on Geologic Unit 24 (Lower Red Claystone) by pumping water from well RFI-16. Nearby observation wells (RW-1, RFI-13. RFI-8, and RFI-14) in Geologic Unit 22 (Upper Red Claystone) unit were monitored during the test. A response was observed in RW-I minutes after the stress was initiated, indicative of non-laminar flow conditions near well RW-1.

The second test, a long term (2 week) pump test was conducted in Geologic Unit 22 (Upper Red Claystone) by pumping groundwater from well RFI-14, with the effects monitored in observation wells including RW-1. Changes in the potentiometric surface of almost three feet were observed in monitoring wells located from 20 to 200 feet up-gradient, down-gradient, and cross-gradient from the pumping well. Conversely, monitoring wells very near the pumping well, but outside of the secondary permeability zone, showed very little effect. This type of response is indicative of a media with dual porosity and primary and secondary permeability zones (USPC1, 1995). This aquifer test was used to calibrate the Cell 5 contaminant fate and transport model (USPC1, 1996).
An aquifer pump test was also conducted up-gradient of Cell 5 with boring ST-23 as the pumping well, and borings ST-3, ST-26, ST-27, ST-28, ST-4, ST-5 used as observation wells (USPC1, 1996).

The pump test was started on July 23,1996 and ended on September 4,1996. Analysis of water level data in the observation wells was conducted to calculate transmissivity and storage coefficient, using the computer program, AQTESOLV. Two observation wells were chosen for curve matching solution in AQTESOLV because of their proximity to ST-23. Observation wells ST-3, ST-4, ST-5, and ST-28 did not show any effect from pumping ST-23. The Theis curve calculations for well ST-26 resulted in a transmissivity of 7.06 x 10^{-4} cm^2/sec, and the Neuman curve provided a transmissivity of 1.15 x 10^{-3} cm^2/sec for well ST-27 (USPC1, 1996).

Geophysical Log Analysis

Volan log analysis was applied to borehole geophysical logs to produce a graphic display of hydraulic conductivity, saturation, and bound water for several test holes. The results of this investigation, along with copies of all the geophysical logs conducted at the facility are included as Appendix 3.12: *Geophysical Logs and Log Analysis Reports*. The values for hydraulic conductivity derived from this analysis ranged from 3.5 x 10^{-6} to 8.9 x 10^{-5} cm/sec, resulting in Darcian velocities of 1.4 x 10^{-7} to 3.5 x 10^{-6} cm/sec. Furthermore, the log analytical results indicated saturated conditions for the intervals of interest in the selected test holes (USPC1, 1988).

3.1.3.2.2. Site Hydrogeochemistry

The most important factors controlling the hydrogeochemistry of the local groundwater flow regime include the recharge of fresh water from precipitation onto the Blaine Formation and the Flowerpot Shale and the mineralogy and trace element content of the soil and rock beneath the site. The site bedrock lithology and mineralogy have been presented in a previous section (3.1.2.2.4, Site Lithological Analysis).

Two geochemical types of groundwater have been identified within the Flowerpot Shale based on chemical analysis of the major cations and anions. These two types of water include a Ca-Mg-$S0^4$ or sulfate-influenced groundwater, and a NaCl or chloride-influenced groundwater (USPCI, 1991). The sulfate water occurs in the local flow regime and is controlled by recharge at local topographic highs capped by the Blaine Formation and hills in the upper part of the Flowerpot Shale. The leaching of calcium and sulfate from gypsum in these formations during recharge causes elevated concentrations of these parameters in shallow, relatively young groundwater. Geologic Unit 23 (First Green Claystone) controls the mixing of the sulfate influenced groundwater with the deeper chloride-influenced groundwater. A groundwater sample was designated to have a Ca-Mg-SO^4 (sulfate) influence if the concentration of sulfate was greater than 15% of the total anion concentration (USPCI, 1991). The chloride water is derived from a regional flow regime within the Flowerpot Shale.

The groundwater in the Flowerpot Shale, which contains both local and regional groundwater, can best be described as brine with TDS ranging to over 100,000 mg/L. This brine contains 8,000 to 50,000 mg/L sodium, 2,000 to 100,000 mg/L chloride, 500 to 1,000 mg/L magnesium, and 4,000 to 10,000 mg/L sulfate (USPCI, 1987). Additional information regarding the geochemistry of the site groundwater is provided in Section 3.2.4.1 (Hydrogeochemistry Analysis Description) and Appendices 3.13, 3.14, and 3.15.

3.1.4. SITE HYDROGEOLOGIC CONCEPTUAL MODEL

To date, there are data from four-hundred and eight (408) borings, two-hundred and thirty-nine (239) of which are groundwater monitoring locations on the site. Over one-hundred and fifty-four (154) logged soil borings have been advanced into the shallow subsurface at the site. From those wells and borings, 20,936 water levels have been recorded in the relational database and 347,816 different groundwater quality analyses have been performed. This subsection consolidates all of this hydrogeological information and results from the many tests performed on site porous media and reduces it into a concise, site hydrogeological conceptual model.

Groundwater at the facility can be segregated into two different flow regimes: local flow and regional flow regime, similar to the small drainage basins described by Toth (1963). The local flow regime is controlled by the local topography and recharge. At the Lone Mountain Facility, the boundary between the two flow regimes is established primarily on stratigraphy as well as differences in potentiometric surface and groundwater geochemistry (see Section 3.1.3.2.2). The stratigraphic boundary of the two flow regimes is considered to be Geologic Unit 23 (First Green Claystone), a relative aquitard located at an approximate elevation of 1,365 feet (amsl). A schematic of the generalized groundwater flowpath at the facility is shown in Figure 3.13: *Conceptual Site Hydrogeologic Model*.

Since the shallowest water-bearing unit underlying the site is in the local groundwater flow regime, and given the relative disconnection in the local and regional flow regimes, the hydrogeologic conceptual model focuses primarily on the local flow regime. If a contaminant is accidentally released into the subsurface, it would first be detected in the local groundwater flow regime. As demonstrated in the accidental release near Cell 5, Geologic Unit 23 (First Green Claystone) acts as a relative aquitard to both groundwater flow and contaminant transport, isolating fluid in the local flow regime from the regional flow regime. Recharge of the local and regional flow regimes as used in the model is discussed in Section 3.1.3.1.2 and Section 3.1.3.2.1.2.

3.1.4.1. Site MODFLOW Groundwater Flow Model

Two quantitative groundwater numerical models were developed as part of the Cell 5 Corrective Action activities at the facility. One model, the site-wide scale model, was developed using information from detection monitoring, facility siting, and corrective action (RFI/CMS) information. The other model, the Plume-Scale contaminant fate and transport model, was developed as a telescopic mesh refinement of the site-wide scale model. An overview of the relationship between the site-scale model and the plume-scale model is shown in Figure 3.14: *Site MODFLOW Groundwater Flow Model*. A detailed description of the MODFLOW Model is provided in Appendix 3.13: *MODFLOW Groundwater Modeling Documentation Information*.

The site-wide scale model was developed using the MODFLOW simulator (McDonald and Harbaugh, 1988). MODFLOW is a quasi-3-dimensional groundwater flow simulator developed for the United States Geological Survey (USGS). The model provides a 3-dimensional representation of groundwater flow in the southern half of the facility near Cells 1-7. The model incorporates specific attributes that exist at the facility including aspects of hazardous waste cell construction and average leachate production as well as surface water features, such as the sanitary lagoon and retention pond located near the Drum Cell. This model takes full advantage of the capabilities of MODFLOW by simulating four water-bearing units at the site: the shallow fill material and the three red claystone lithofacies each separated by a green claystone lithofacies. Based on field information, the green claystone lithofacies were modeled as having a resistive vertical hydraulic conductivity three orders of magnitude greater than the horizontal hydraulic conductivity of the red claystone. The model simulates flow to a depth of approximately 80 feet below the bottom of Cell 5. The aerial extent of the model domain is approximately 145 acres from the top of the bluff to the west past the facility boundary to the east.

The site-scale model was used to simulate large scale stresses on the porous media. It was also used to estimate the site-scale effective hydraulic conductivity of the red claystone. The model was calibrated by comparing predicted heads to observed heads at monitoring wells and varying the red claystone hydraulic conductivity until a reasonable match was achieved. Results of an initial simulation were used to provide a 3-dimensional flow net of the groundwater flow in the vicinity of Cell 5 as part of the corrective action activities in the area. MODPATH (Pollack, 1989), a particle tracking algorithm developed as a post-processor for MODFLOW, was used to delineate groundwater flow paths.

The Plume-Scale contaminant fate and transport model was designed using the Swift III simulator (GeoTrans, 1990). This simulator uses estimates of the fate and transport process to predict the migration of solute phase constituents. This algorithm can simulate fracture flow and/or dual porosity scenarios but it cannot simulate NAPL flow.

The Plume-Scale model domain is a subset of the site Site-Scale model with a finer resolution. The Plume-Scale model prescribes boundary conditions from information derived from the Site-Scale model. The Plume-Scale model was used to predict the effects from various corrective measures alternatives in the area near Cell 5.

These hydrologic models were developed to evaluate remediation options and the performance of remediation systems. If hydrogeologic and contaminant conditions change at the site, the models could be used to evaluate corrective measure alternatives. Piezometric data gaps can be identified and new wells appropriately sited to fill these gaps. The proper well spacing can be predicted to evaluate changes in contaminant conditions. Contaminant plume growth and contraction can be simulated for various types of remediation systems. Changes in water table elevations can be simulated due to rainfall variations, dewatering, new construction and paving, or other changes to facility configuration.

Figures

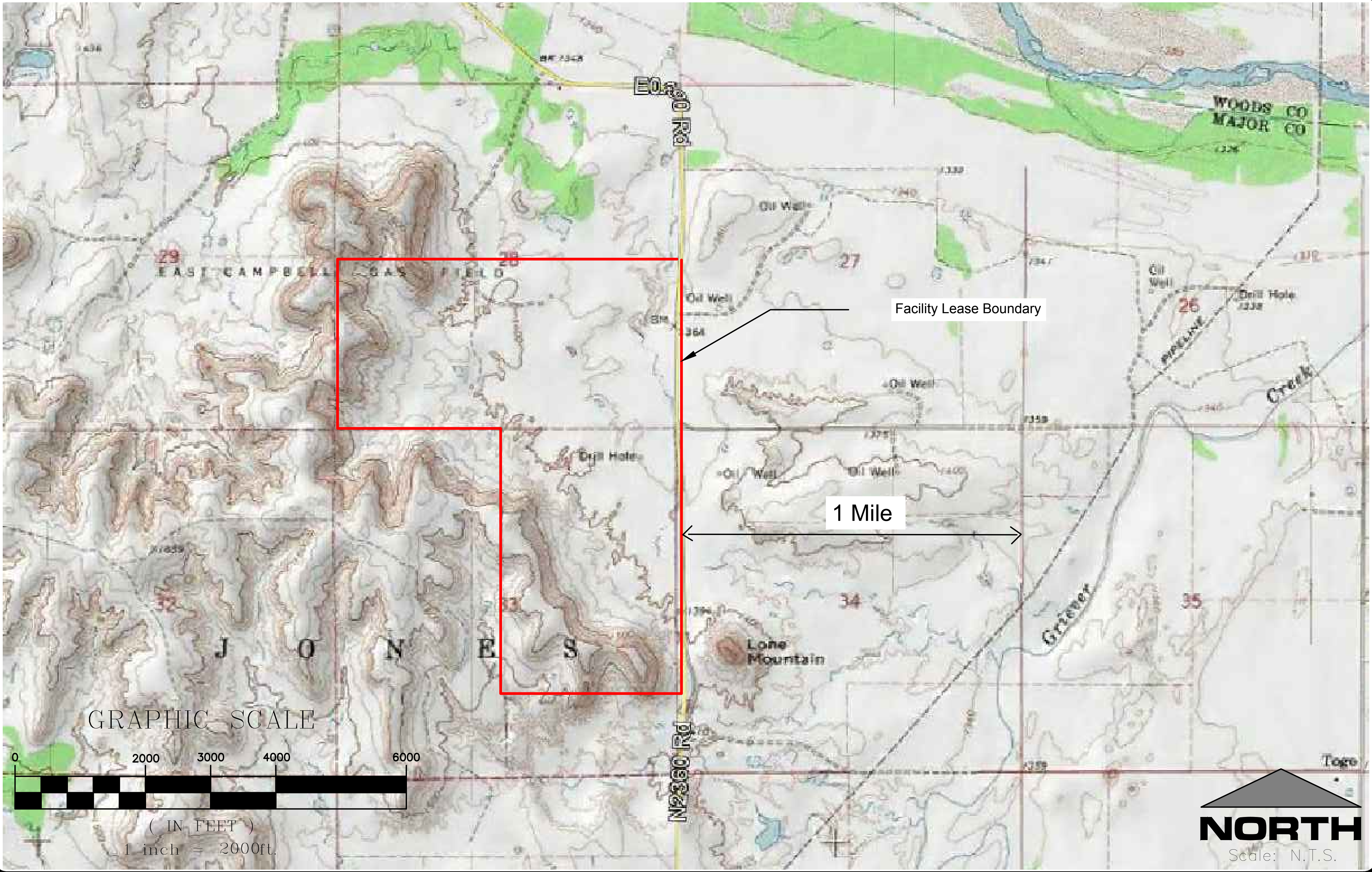

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Figure 3.1 - Site and Topography Map

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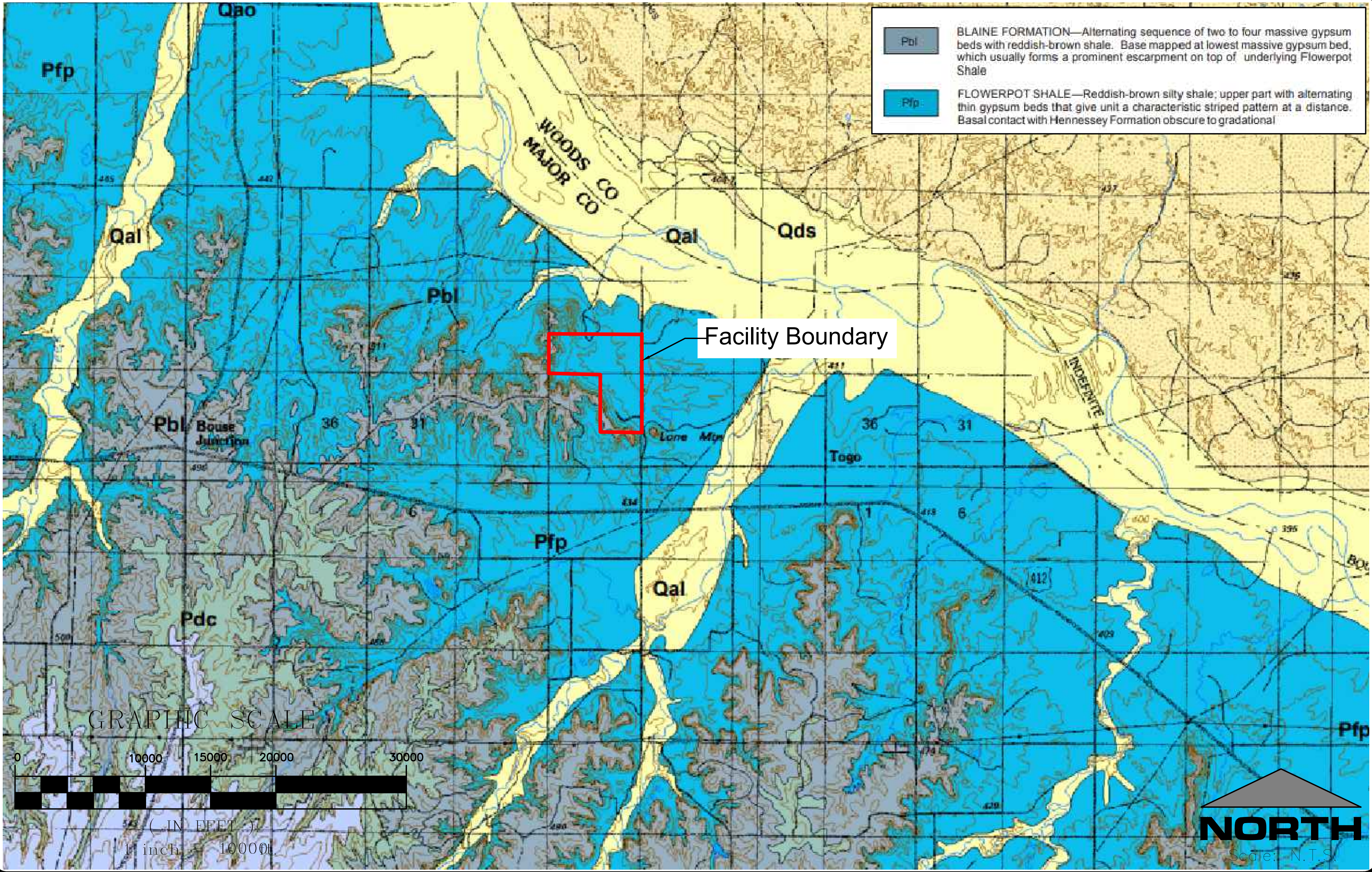

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Figure 3.2 - Regional Geological Map

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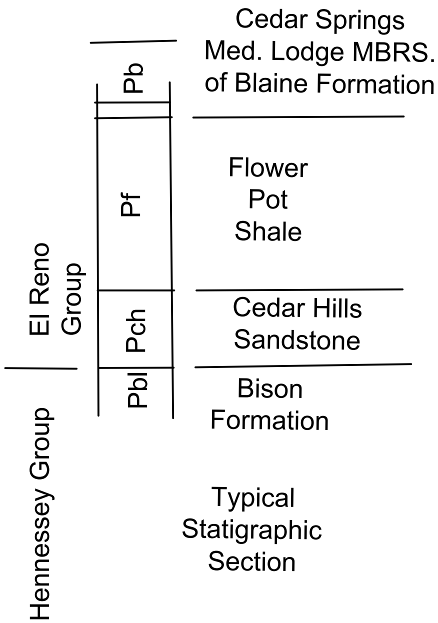

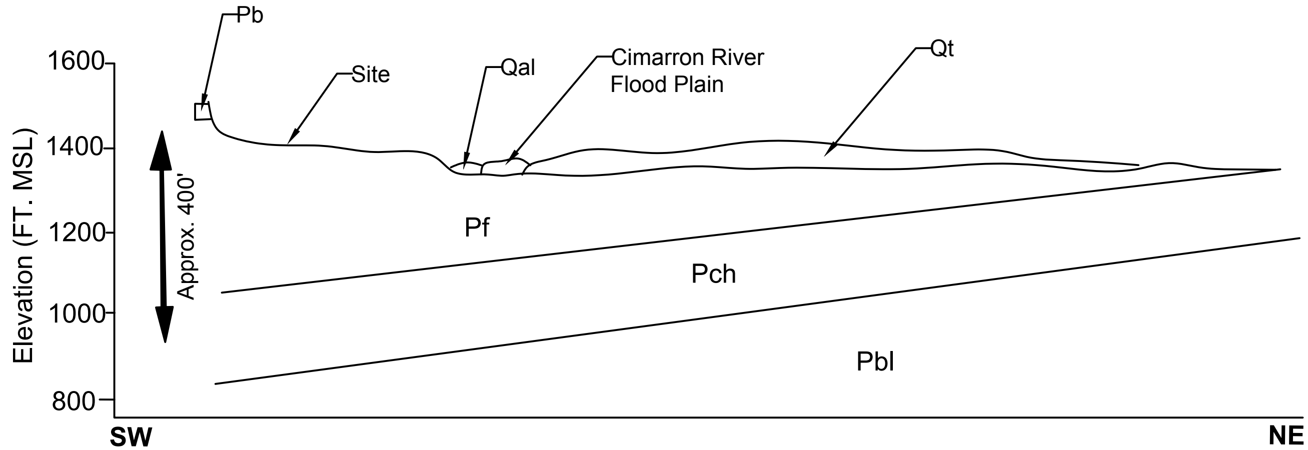

LEGEND

Qal	Quaternary Alluvium
Qt	Quaternary Terrace Deposits
Pb	Permian Blaine Formation
Pf	Permian Flower Pot Shale
Pch	Permian Cedar Hills Sandstone
Pbl	Permian Bison Formation

Vertical Exaggeration = 35X

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Figure 3.3 - Conceptual Regional Geologic Cross Section

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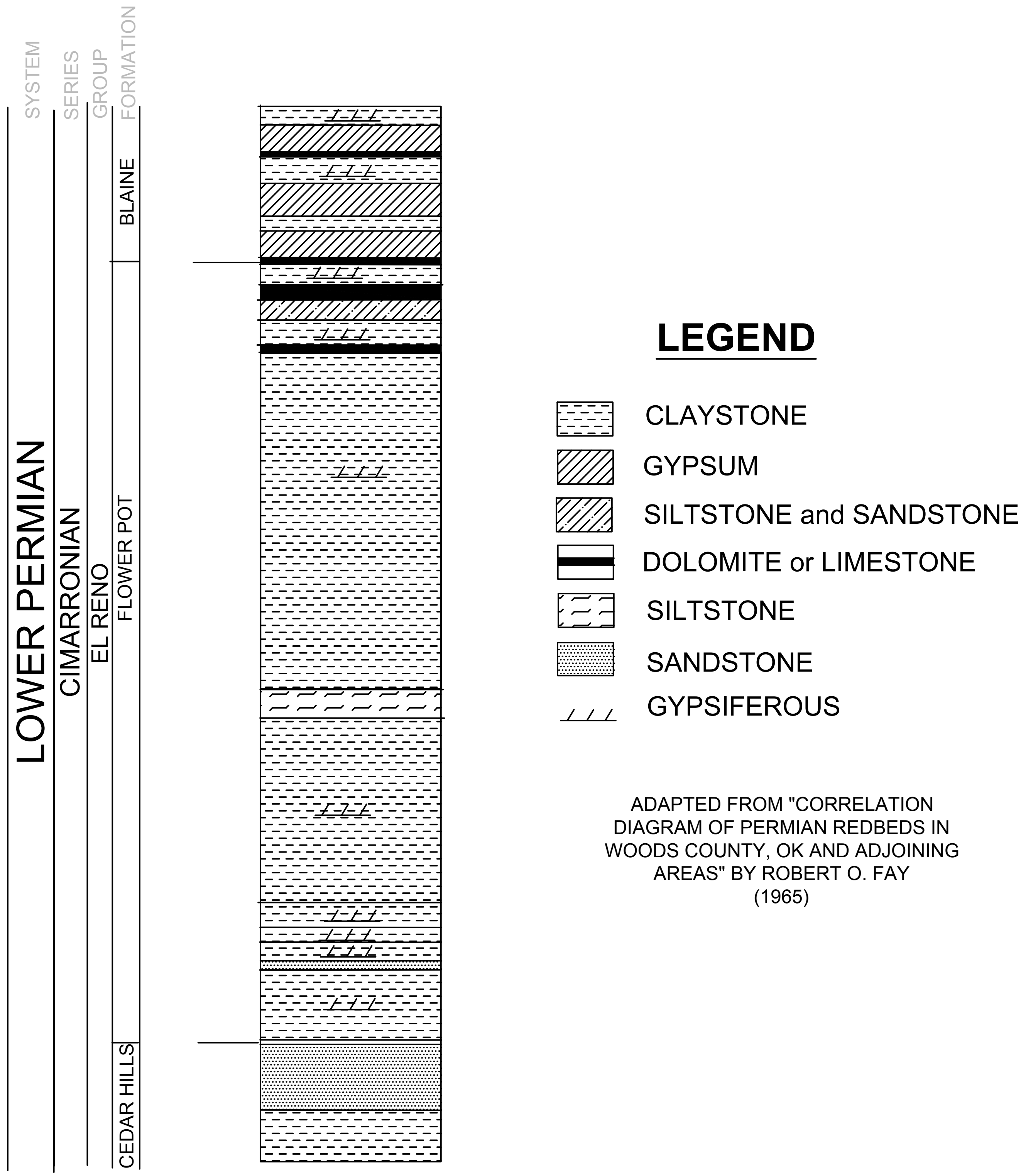

ADAPTED FROM "CORRELATION DIAGRAM OF PERMIAN REDBEDS IN WOODS COUNTY, OK AND ADJOINING AREAS" BY ROBERT O. FAY (1965)

N.T.S.

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Figure 3.4 - Stratigraphic Column

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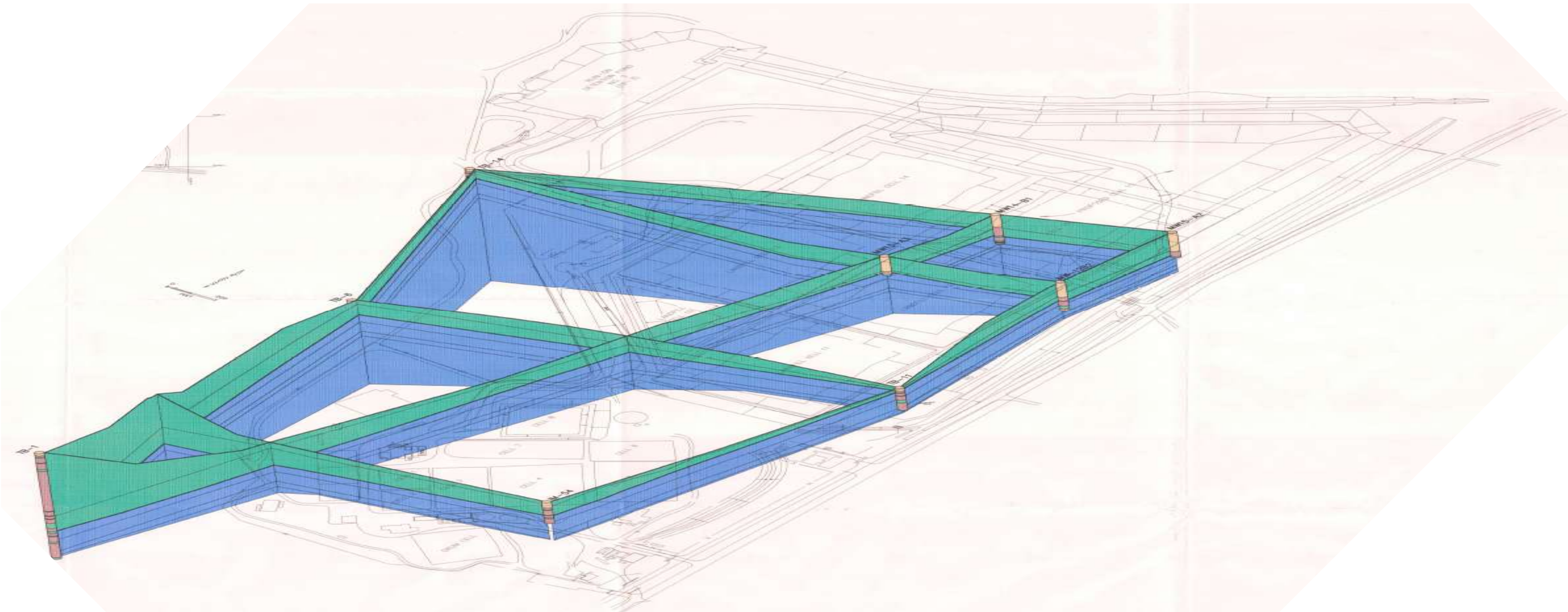

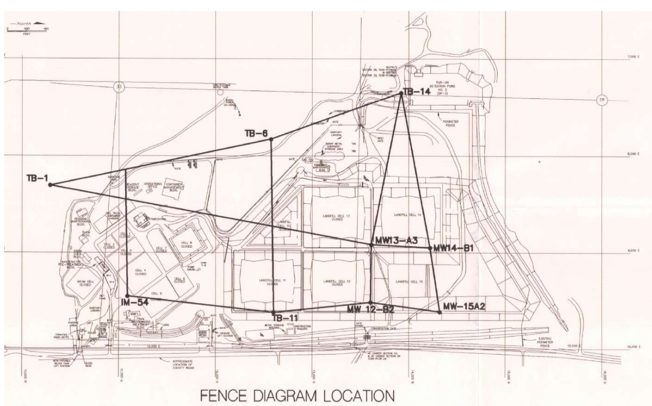

Note: Figure originally drawn by
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3/22/1999
Not to Scale

LEGEND

- FILL MATERIAL
- GREEN CLAY MATERIAL
- RED CLAY MATERIAL
- LOCAL GROUNDWATER FLOW REGIME
- REGIONAL GROUNDWATER FLOW REGIME
- MARKER BEDS

NOTE: FENCE DIAGRAM VERTICALLY EXAGGERATED

Legend

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Figure 3.5:
Fence Diagram

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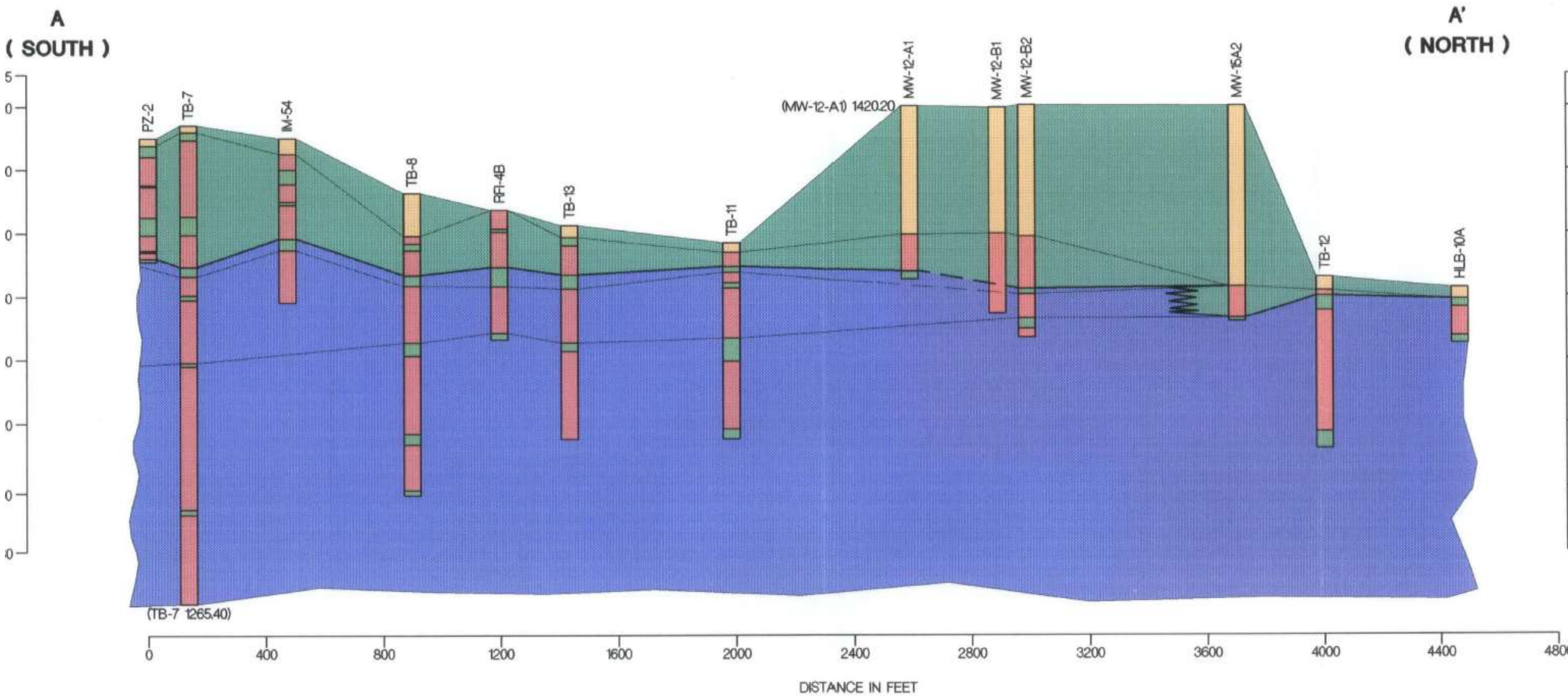

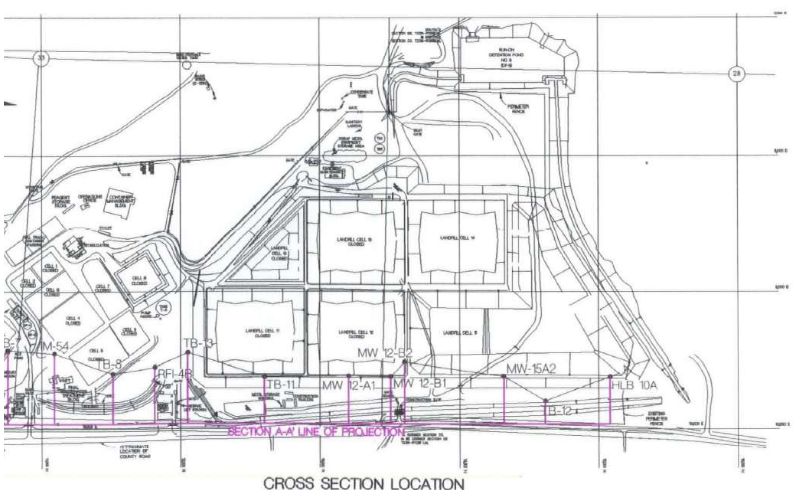

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—North

LEGEND

- FILL MATERIAL
- GREEN CLAY MATERIAL
- RED CLAY MATERIAL
- LOCAL GROUNDWATER FLOW REGIME
- REGIONAL GROUNDWATER FLOW REGIME

Legend

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Figure 3.6: North-South Cross Section A-A'

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Figures3.5-3.6-3.7 -Fence& X-Sect.ppt

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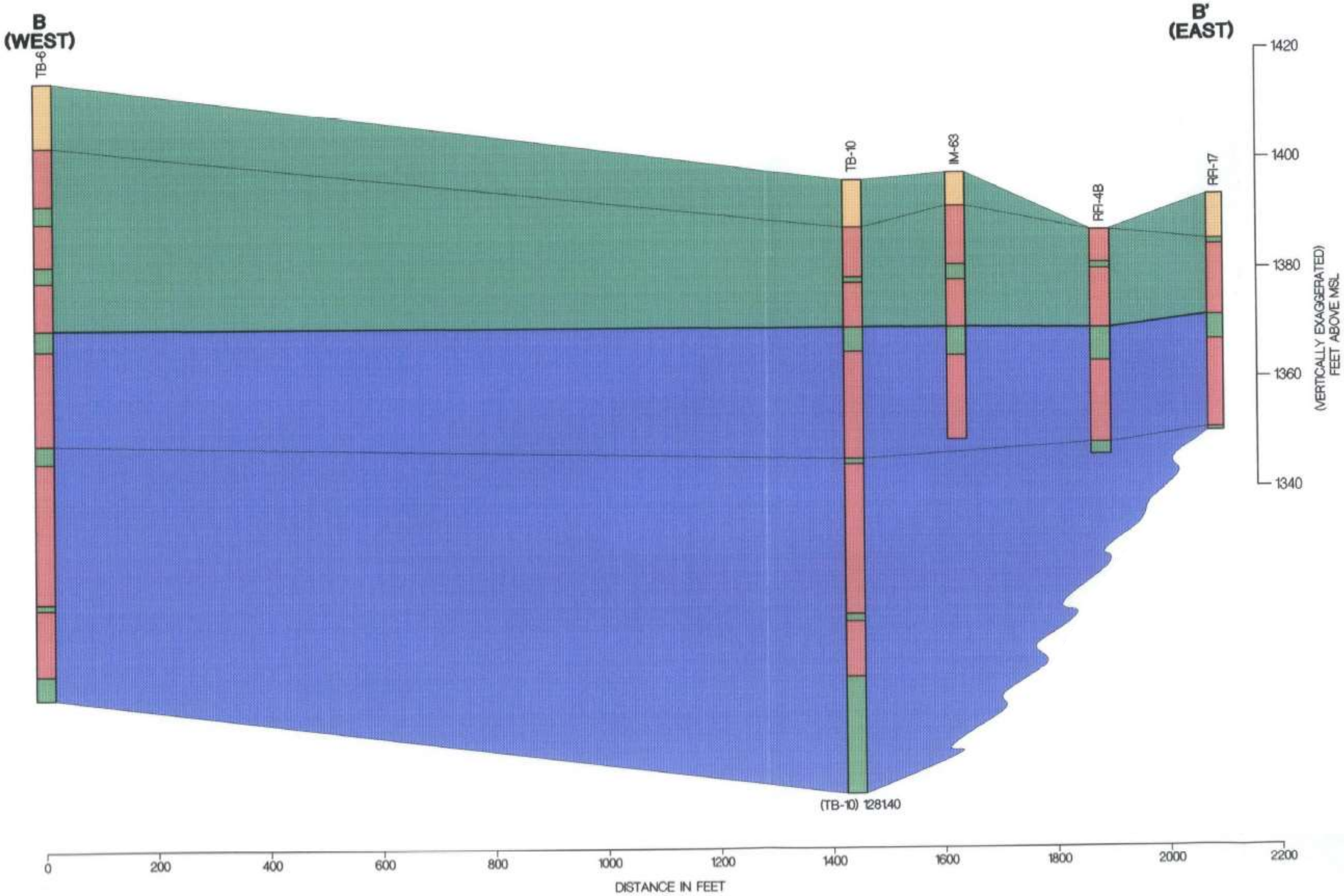

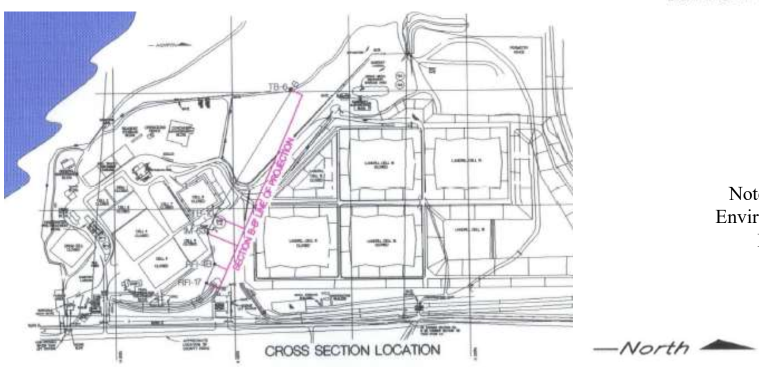

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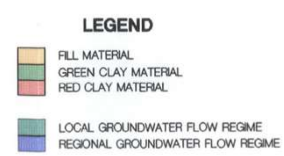

Legend

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Figure 3.7:
East-West Cross
Section B-B'

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X-Sect.ppt

Leppert Associates

Figure 3.8
Regional Water-Bearing Units of the Lone Mountain Facility

Geologic Age	Geologic Unit	Geologic Map Symbol	Unit Description
Quaternary (Pleistocene)	Alluvium	Qal	Lenticular and interfingering deposits of gravel, sand, silt, and clay. Generally light-tan to gray. Thickness along major streams ranges up to 100 feet and probably averages 40 feet; along minor streams the thickness ranges up to 45 feet and probably averages 20 feet.
	Terrace Deposits	Qt	Lenticular and interfingering deposits of light-tan to gray gravel, sand, silt, clay, and volcanic ash. Sand dunes are common in many places. Thickness ranges up to 150 feet and averages about 60 feet.
Lower Permian (El Reno Group)	Blaine Formation	Pb	Alternating cyclic sequence of 3 or 4 massive gypsum beds with red-brown shales, generally with a named dolomite at the base of each gypsum, and a greenish-gray shale at the base of each dolomite. The named, unmapped sequence is (ascending) Cedar Springs Dolomite, Medicine Lodge Gypsum, Shale, Magpie Dolomite, Nescatunga Gypsum, Shale, Altona Dolomite, Shimer Gypsum, Shale, and Haskew Gypsum at top. Thickness ranges up to 90 feet, with the shales being northward.
	Flowerpot Shale	Pf	Red-Brown silty shale with some thin gypsum and dolomite beds in the upper part to north. The middle and upper parts contain 50 feet or more of rock salt in the intermediate subsurface, giving origin to the Ferguson Salt Plain in Blaine County and the Big and Little Salt Plains in Woods and Harper Counties on the Cimarron River. Thickness ranges from 180 feet in north part to 430 feet in south part. The Chickasha Formation (Pc) is a deltaic tongue of red-brown to greenish-gray to orange-brown cross-bedded mudstone conglomerate, siltstone, shale, and fine-grained sandstone about 30 feet thick in the middle of the flowerpot that pinches out northward.
	Cedar Hills Sandstone	Pch	Orange –brown to greenish-gray fine grained sandstone and siltstone with some red-brown shale. Thickness ranges up to 180 feet with more sandstone to the north and more shale to the south.

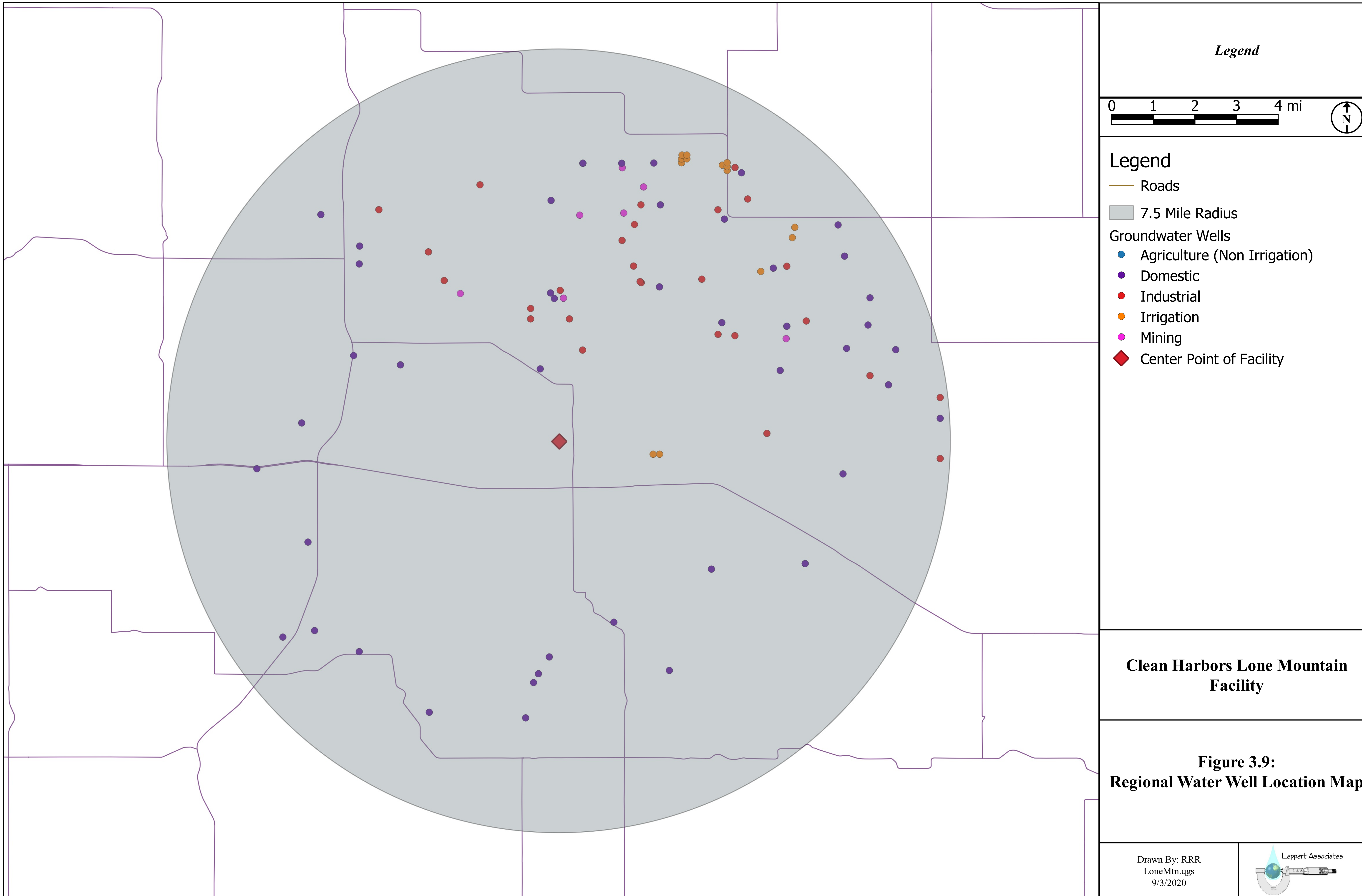

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Figure 3.9: Regional Water Well Location Map

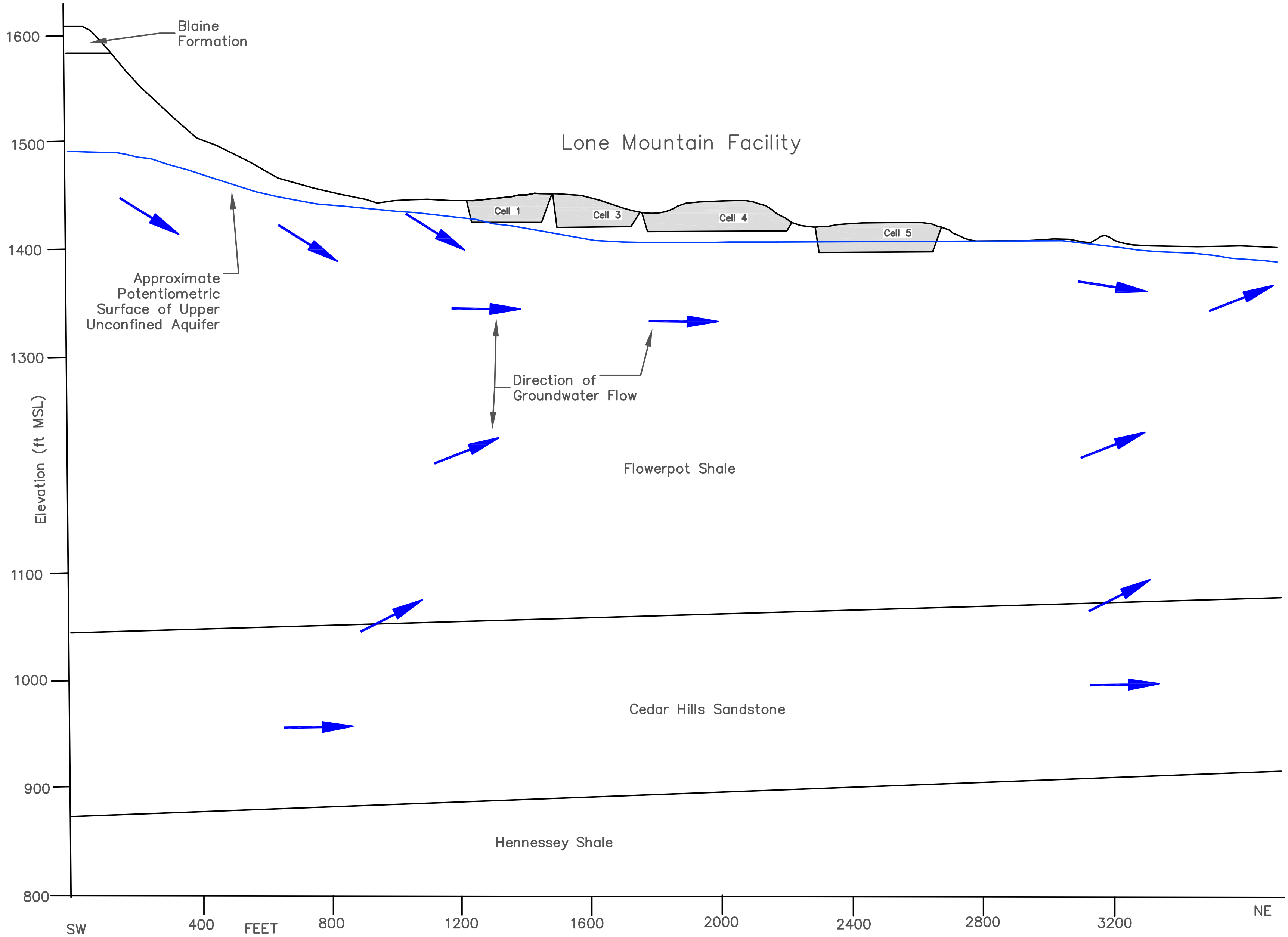

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Figure 3.10 — Regional Groundwater Flow Diagram

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Phone (580) 234-8780, Fax (580) 237-4302
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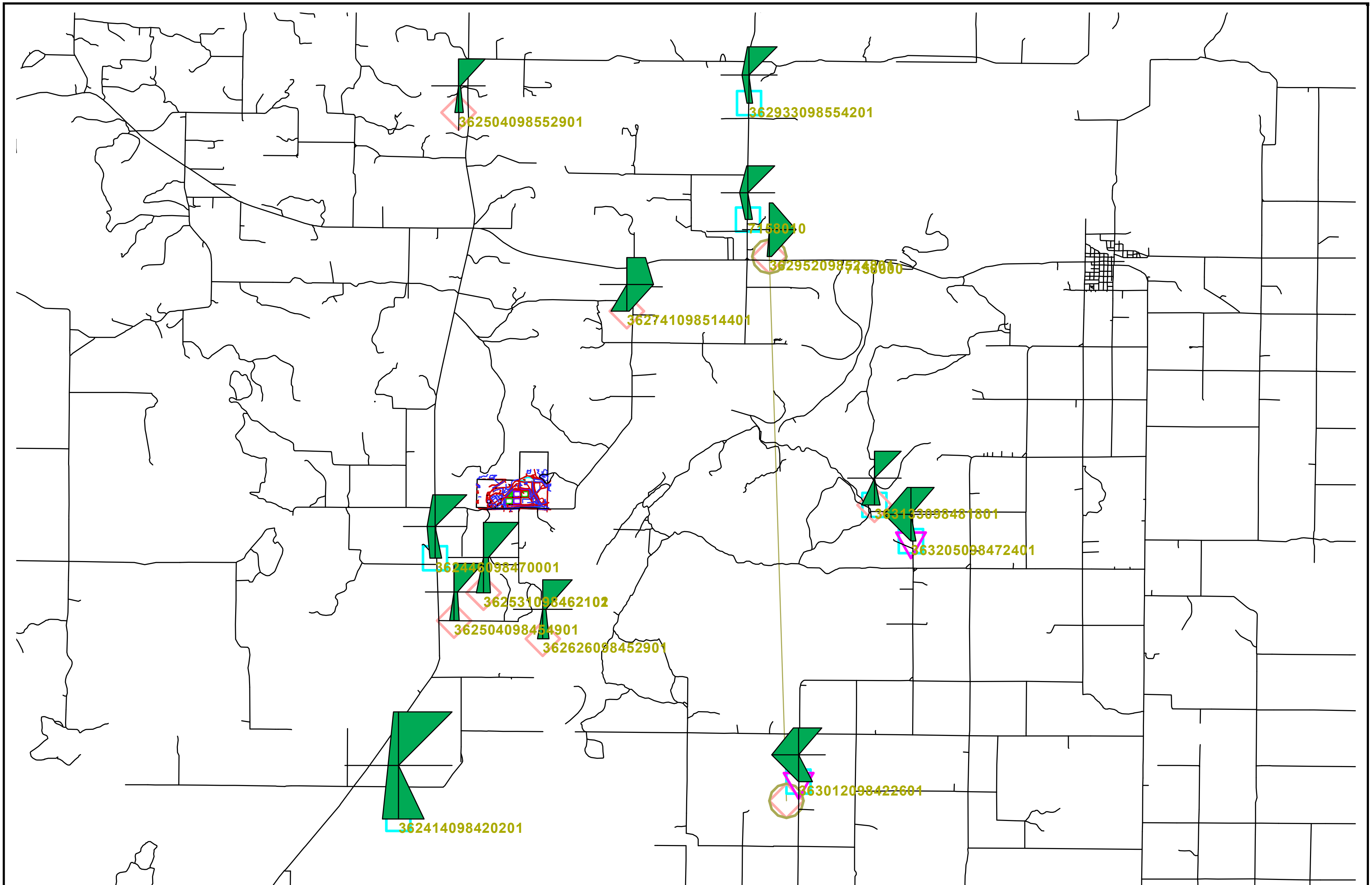


Legend

Scale: (miles)

0 0.75 1.50 2.25

N

Missing HCO3 Data

Missing Mg & Ca Data

Duplicate Data 2x Locations

Missing Na & K Data

####### USGS Site Number

Example Stiff Plot

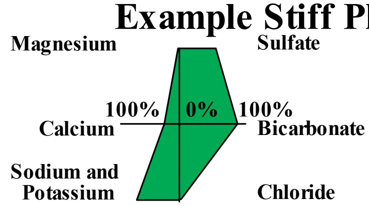


Figure 3.11: Regional Geochemistry Map

Source: United States Geological Survey http://nwis.waterdata.usgs.gov /ok/nwis (Queried July 2009)

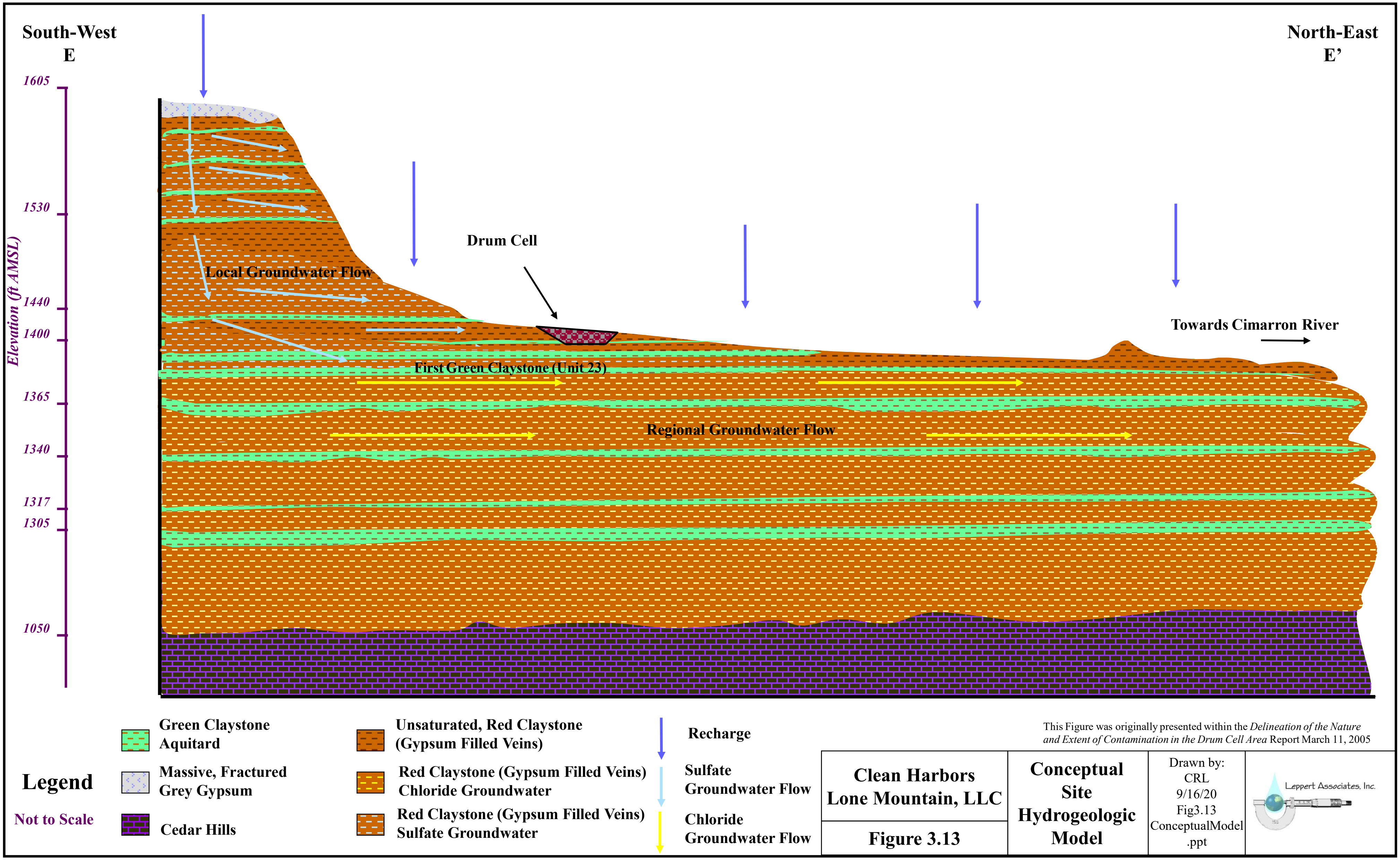
Clean Harbors Lone Mountain Facility

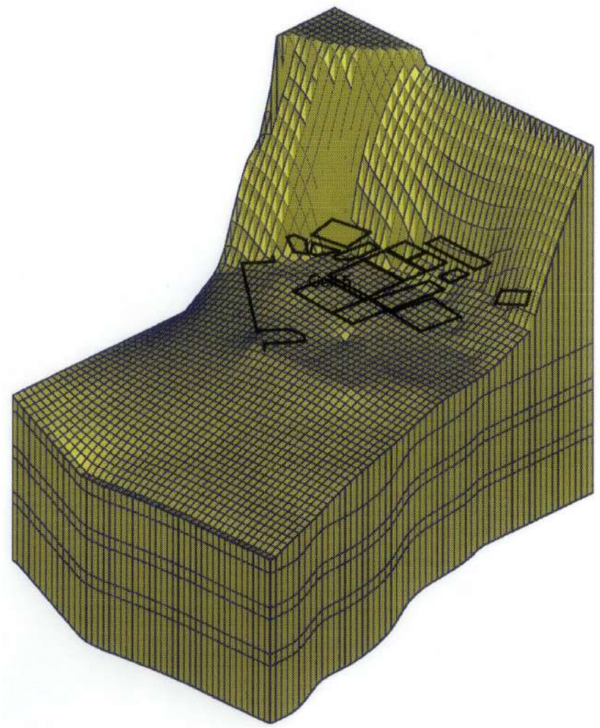
Drawn By: TFB 9/16/2020 Basemap.lpk

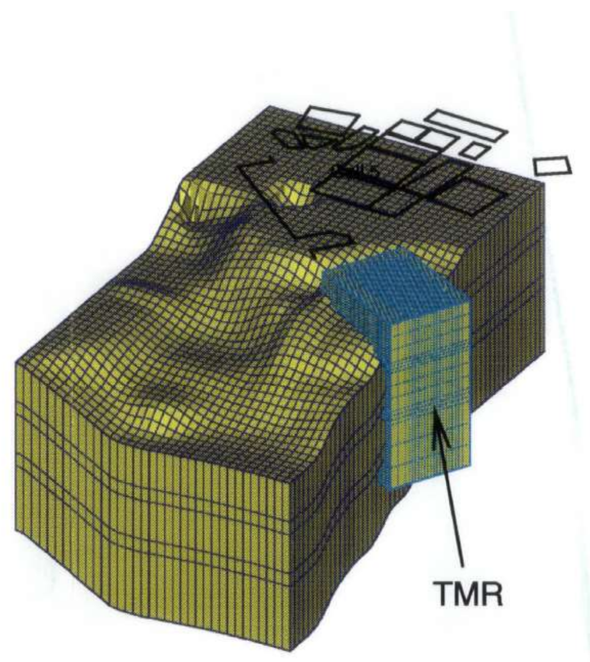
Leppert Associates

Figure 3.12
Site Water-Bearing Unit Description
9-16-2020

Geologic Unit	Geologic Unit Location	Approximate Elevation (Feet, MSL)		Used for Subsurface Correlation			Used for Groundwater Flow Characterization Studies		
		Top	Bottom	Geologic Unit Designation	Thickness of Geologic Unit	Color/Type of Geologic Layer	Hydrogeologic Flow Unit (1998)	Historical Aquifer Classification (1987)	Cell 5 Investigation Aquifer Classification (1994-96)
Blaine Formation		Variable		0	Variable	Fill Material	Local Groundwater Flow Regime	Upper Unconfined Aquifer	Fill Material
	Top of Lone Mtn.	1,605	1,600	1	5	Gypsum			
		1,600	1,595	2	9	Red			
Flowerpot Shale		1,595	1,591	3	4	Green			
		1,591	1,577	4	14	Red			
		1,577	1,575	5	2	Green			
		1,575	1,566	6	19	Red			
		1,556	1,551	7	5	Green			
		1,551	1,532	8	19	Red			
		1,532	1,530	9	2	Green			
		1,530	1,438	10	92	Red			
	Highest Pt. on Facility	1,438	1,434	11	4	Green			
		1,434	1,426	12	8	Red			
		1,426	1,424	13	2	Green			
		1,424	1,414	14	10	Red			
		1,414	1,409	15	5	Green			
		1,409	1,401	16	8	Red			
		1,401	1,399	17	2	Green			
		1,399	1,386	18	13	Red			
		1,386	1,382	19	4	Green			Upper Red Claystone
		1,382	1,377	20	5	Red			
		1,377	1,373	21	4	Green			
		1,373	1,366	22	7	Red			
	Lowest pt. on Facility	1,366	1,362	23	4	Green	Regional Groundwater Flow Regime	Aquitard and Aquiclude	1st Green Claystone
		1,362	1,345	24	17	Red			Lower Red Claystone
		1,345	1,340	25	5	Green			2nd Green Claystone
		1,340	1,317	26	23	Red			Interbedded Sequence of Red and Green Claystones
		1,317	1,315	27	2	Green		Upper Confined Aquifer	
		1,315	1,305	28	10	Red			
		1,305	1,300	29	5	Green			
		1,330	1,050	30	250	Red		Aquitard and Aquiclude	
Cedar Hills Sandstone		1,050	875	31	175	Cedar Hills Sandstone		Lower Confined Aquifer	Cedar Hills Sandstone


South-West
E
North-East
E'
1605
1530
1440
1400
1365
1340
1317
1305
1050
Elevation (ft AMSL)
Drum Cell
Local Groundwater Flow
Towards Cimarron River
First Green Claystone (Unit 23)
Regional Groundwater Flow
Legend
Not to Scale
Green Claystone Aquitard
Massive, Fractured Grey Gypsum
Cedar Hills
Unsaturated, Red Claystone (Gypsum Filled Veins)
Red Claystone (Gypsum Filled Veins) Chloride Groundwater
Red Claystone (Gypsum Filled Veins) Sulfate Groundwater
Recharge
Sulfate Groundwater Flow
Chloride Groundwater Flow
This Figure was originally presented within the Delineation of the Nature and Extent of Contamination in the Drum Cell Area Report March 11, 2005
Clean Harbors Lone Mountain, LLC
Figure 3.13
Conceptual Site Hydrogeologic Model
Drawn by: CRL 9/16/20 Fig3.13 ConceptualModel .ppt
Leppert Associates, Inc.





Note: Figure originally drawn by:
USPCI
10/1996
Not to Scale

Legend

Clean Harbors
Lone Mountain, LLC

Figure 3.14:
Site MODFLOW
Groundwater Flow Model

Drawn b y: AJE
09/15/20
Figures3.5-3.6-3.7
-Fence&
X-Sect.ppt

Leppert Associates

Tables

Table 3.1:
Water Supply Wells within a 7.5 Mile Radius of the Lone Mountain Facility
Clean Harbors, LLC - Lone Mountain Facility

OWRB WELL ID	OWNER NAME	LATITUDE	LONGITUDE	Quadrant	DATE CONSTRUCTED	USE	WELL TYPE	TOTAL DEPTH (feet)	DISTANCE FROM SITE (miles)
110496	Davidson, Larry	36.418581	-98.774589	NE	7/27/2006	Agriculture (non irr)	Groundwater Well	32	1.831103933
18715	Bonray	36.465422	-98.743969	NE	12/19/1983	Industrial	Groundwater Well	100	4.241220637
143475	BRUD BAKER	36.46995	-98.7485	NE	5/14/2012	Domestic	Groundwater Well	80	4.246013003
18645	Vern A Bell	36.458537	-98.876453	NE	8/27/1979	Domestic	Groundwater Well	38	4.479979859
155351	Brian Langston	36.415975	-98.889951	NE	7/25/2013	Agriculture (non irr)	Groundwater Well	200	4.809081735
18723	Tuthill and Barbee	36.498531	-98.783171	NE	12/29/1983	Industrial	Groundwater Well	85	4.981443883
107506	chesapeak	36.4644	-98.72615	NE	12/13/2006	Mining	Groundwater Well	100	5.03487893
115891	Keith Johnson	36.468726	-98.725924	NE	8/23/2007	Domestic	Groundwater Well	125	5.198782699
115892	Keith Johnson	36.468726	-98.725924	NE	8/25/2007	Domestic	Groundwater Well	130	5.198782699
18644	Hickman Drilling	36.494524	-98.850474	NE	6/1/1978	Industrial	Groundwater Well	19	5.209437435
169135	Warren Oshel	36.46848109	-98.72228542	NE	12/31/1999	Agriculture (non irr)	Groundwater Well	92.4	5.36247724
18701	Thane Sargent	36.487744	-98.734981	NE	10/9/1970	Irrigation	Groundwater Well	32	5.644504603
39071	RAY HULL	36.505916	-98.747611	NE	6/5/1997	Domestic	Groundwater Well	79	6.223102913
113970	Tom Ward	36.4483667	-98.6906	NE	12/5/2007	Domestic	Groundwater Well	50	6.509723253
18792	Hickman Drilling	36.509182	-98.86767	NE	10/30/1978	Industrial	Groundwater Well	20	6.569076554
92697	G. E. Kanaga	36.52376847	-98.78309103	NE	1/21/2005	Mining	Groundwater Well	50	6.688721722
18752	Magic Circle	36.512912	-98.73951	NE	11/30/1981	Industrial	Groundwater Well	45	6.870940972
95927	Gary Kanaga	36.5276	-98.7830667	NE	8/15/2005	Agriculture (non irr)	Groundwater Well	45	6.949703455
165610	Zook, Dale	36.5268333	-98.7606667	NE	1/21/2015	Irrigation	Groundwater Well	52	7.222674586
110957	Ryan Redgate	36.5228333	-98.7466667	NE	4/16/2007	Irrigation	Groundwater Well	52	7.275547566
165608	Zook, Dale	36.5281667	-98.7606667	NE	1/20/2015	Irrigation	Groundwater Well	58	7.309422525
113511	Jim Edwards	36.3502636	-98.7167342	NE	11/28/2006	Agriculture (non irr)	Groundwater Well	44	7.319451439
110958	Ryan Redgate	36.5241667	-98.7466667	NE	4/17/2007	Irrigation	Groundwater Well	50	7.358200325
18721	Ran Ricks Inc	36.42275	-98.672636	NE	12/6/1986	Industrial	Groundwater Well	25	7.378005688
45296	Elmer Maddux	36.436726	-98.672643	NE	3/11/1999	Domestic	Groundwater Well	80	7.386507758
18750	Magic Circle Energy	36.523839	-98.743931	NE	6/26/1981	Industrial	Groundwater Well	60	7.406396773
18751	L B Jackson Drilling	36.523839	-98.743931	NE	9/22/1978	Industrial	Groundwater Well	60	7.406396773
18642	Top Drilling	36.443954	-98.672643	NE	2/23/1979	Industrial	Groundwater Well	46	7.440538426
Total Wells Present in Quadrant									**28**
129659	Matt Lyons	36.4629667	-98.83065	NW	4/5/2010	Agriculture (non irr)	Groundwater Well	30	2.767633111
37704	MAJOR COUNTY RURAL WATER DIST	36.480267	-98.808029	NW	11/29/1994	Domestic	Groundwater Well	33	3.571885272
105156	Larry Davidson	36.4553	-98.8601833	NW	9/21/2006	Domestic	Groundwater Well	20	3.580144353
106578	Bob Vavalry	36.462084	-98.856408	NW	7/5/2006	Agriculture (non irr)	Groundwater Well	23	3.676780034
18727	Hickman Drilling	36.465913	-98.749833	NW	5/3/1985	Industrial	Groundwater Well	120	4.006532999
28408	Logan Drilling	36.48007	-98.839352	NW	12/2/1991	Mining	Groundwater Well	22	4.035504715
106840	Gene Gard	36.4408	-98.732433	NW	12/29/2006	Agriculture (non irr)	Groundwater Well	24	4.12422299
18726	Donald Slawson	36.4838436	-98.77650616	NW	9/17/1981	Industrial	Groundwater Well	70	4.131491721
18724	Donald Slawson Inc	36.484194	-98.776918	NW	9/19/1981	Industrial	Groundwater Well	60	4.145192759
103209	Brad Hutchison	36.35385	-98.8084667	NW	7/11/2006	Domestic	Groundwater Well	40	5.179624731
38855	WESTERN PLAINS MATERIALS	36.393744	-98.892301	NW	6/18/1997	Domestic	Groundwater Well	100	5.427295515
18587	Strecher Investments	36.386255	-98.719555	NW	9/22/1988	Domestic	Groundwater Well	43	5.588938561

Table 3.1:
Water Supply Wells within a 7.5 Mile Radius of the Lone Mountain Facility
Clean Harbors, LLC - Lone Mountain Facility

OWRB WELL ID	OWNER NAME	LATITUDE	LONGITUDE	Quadrant	DATE CONSTRUCTED	USE	WELL TYPE	TOTAL DEPTH (feet)	DISTANCE FROM SITE (miles)
18588	Strecker Investments	36.386255	-98.719555	NW	9/22/1988	Domestic	Groundwater Well	43	5.588938561
118550	Jerry Nickelson	36.490912	-98.869803	NW	4/5/2008	Agriculture (non irr)	Groundwater Well	35	5.614431034
169971	Kyle Taylor	36.49035	-98.8745	NW	8/4/2015	Domestic	Groundwater Well	30	5.756821766
18778	Jack Kelsey	36.512416	-98.807835	NW	12/16/1985	Domestic	Groundwater Well	53	5.793717001
100525	Allied Gypsum	36.419213	-98.910069	NW	1/2/2006	Domestic	Groundwater Well	65	5.884214578
18717	Bonray Drilling	36.451538	-98.697036	NW	8/3/1983	Industrial	Groundwater Well	100	6.212014247
92694	J. B. Shepherd	36.5170833	-98.7756833	NW	3/8/2005	Mining	Groundwater Well	50	6.3280872
18780	Magic Circle Energy	36.509151	-98.749859	NW	2/11/1981	Industrial	Groundwater Well	50	6.354887737
101892	Gary Kanaga	36.5168414	-98.7669292	NW	4/24/2006	Agriculture (non irr)	Groundwater Well	40	6.454869573
180096	Ryan Choate	36.4691333	-98.6977167	NW	4/19/2017	Domestic	Groundwater Well	35	6.592135674
87944	Paul Ashton	36.4995	-98.724	NW	4/9/1982	Irrigation	Groundwater Well	70	6.655383048
119830	Brad Hutchison	36.3326833	-98.8166667	NW	9/18/2008	Domestic	Groundwater Well	90	6.671779392
180864	Ashton, Terry	36.5030833	-98.72315	NW	4/19/2017	Irrigation	Groundwater Well	72	6.87102103
103268	Alfred Bal	36.36075	-98.9010333	NW	6/7/2006	Domestic	Groundwater Well	50	7.118032154
165609	Zook, Dale	36.5268333	-98.7625	NW	1/21/2015	Irrigation	Groundwater Well	58	7.188505787
165607	Zook, Dale	36.5281667	-98.7623333	NW	1/20/2015	Irrigation	Groundwater Well	58	7.27867899
198783	Dusty Shepard	36.49795	-98.90663	NW	1/28/2020	Agriculture (non irr)	Groundwater Well	32	7.41041538
Total Wells Present in Quadrant									**29**
45638	MAtt Gard	36.424262	-98.770132	SE	1/28/1998	Irrigation	Groundwater Well	36	1.964473188
18731	Hickman Drilling	36.460429	-98.79687	SE	2/19/1981	Industrial	Groundwater Well	18	2.241876798
18730	Ensearch Exploration	36.471263	-98.801462	SE	5/15/1981	Industrial	Groundwater Well	40	2.951695571
155110	Max Redgate	36.46115246	-98.76953454	SE	9/10/2013	Agriculture (non irr)	Groundwater Well	38	2.989577591
18729	E P Operating	36.471263	-98.814945	SE	12/29/1989	Industrial	Groundwater Well	26	2.996649335
18728	Ensearch Exporation	36.474877	-98.814945	SE	12/13/1989	Industrial	Groundwater Well	25	3.242648592
27581	Major Co RWD #1	36.47833708	-98.80670199	SE	6/15/1983	Domestic	Groundwater Well	27	3.435725458
42801	Tuhill & Barby	36.48117	-98.804658	SE	3/19/1988	Industrial	Groundwater Well	40	3.630416037
155109	Max Redgate	36.47076037	-98.7557511	SE	9/9/2013	Agriculture (non irr)	Groundwater Well	72	3.997256632
39072	R D H INTERPRIZES	36.482387	-98.770175	SE	5/27/1997	Domestic	Groundwater Well	93	4.189435218
62610	Steve McKee	36.384345	-98.752133	SE	1/26/2001	Domestic	Groundwater Well	40	4.250438725
18725	Slawson Drilling	36.489615	-98.779166	SE	7/2/1984	Industrial	Groundwater Well	100	4.452782229
197438	Johnsons	36.4784	-98.7469	SE	11/14/2019	Agriculture (non irr)	Groundwater Well	57	4.719444611
106841	Gene Gard	36.4353833	-98.7172833	SE	12/29/2006	Agriculture (non irr)	Groundwater Well	22	4.903334465
18646	Ted Harman	36.435121	-98.894477	SE	8/27/1979	Domestic	Groundwater Well	60	4.999224053
18722	Magic Circle Energy Corp	36.504059	-98.778858	SE	12/10/1981	Industrial	Groundwater Well	61	5.412533687
92698	C & W Construction	36.50803128	-98.78258515	SE	1/24/2005	Mining	Groundwater Well	50	5.628127889
103241	Brad Hutchison	36.34495	-98.8139333	SE	7/12/2006	Domestic	Groundwater Well	50	5.812938544
180289	John Mc Dowel	36.488897	-98.73063	SE	3/27/2017	Domestic	Groundwater Well	52	5.870464653
41320	Herb Holmes	36.349151	-98.766734	SE	5/24/1989	Domestic	Groundwater Well	48	5.899255832
32936	Brown & Cruzen Oil Co.	36.510876	-98.769866	SE	7/25/1995	Domestic	Groundwater Well	75	6.011561023
18702	Magic Circle Energy	36.489551	-98.725927	SE	8/21/1981	Industrial	Groundwater Well	66	6.08886843
18777	Tuthill & Barbee	36.517838	-98.832531	SE	3/14/1984	Industrial	Groundwater Well	60	6.353872831

Table 3.1:
Water Supply Wells within a 7.5 Mile Radius of the Lone Mountain Facility
Clean Harbors, LLC - Lone Mountain Facility

OWRB WELL ID	OWNER NAME	LATITUDE	LONGITUDE	Quadrant	DATE CONSTRUCTED	USE	WELL TYPE	TOTAL DEPTH (feet)	DISTANCE FROM SITE (miles)
32597	Alfred Ball	36.363007	-98.890016	SE	11/14/1994	Domestic	Groundwater Well	79.5	6.560478478
76773	Allen Baird	36.525329	-98.796787	SE	2/24/2003	Domestic	Groundwater Well	68	6.700317722
80661	Allen Baird	36.525329	-98.796787	SE	2/24/2003	Domestic	Groundwater Well	68	6.700317722
86470	Gary Kanaga	36.525329	-98.783294	SE	4/28/2004	Domestic	Groundwater Well	50	6.792864031
142216	Ed Wilcox	36.3346333	-98.8501667	SE	4/2/2012	Domestic	Groundwater Well	50	6.974486607
110961	Ryan Redgate	36.5246667	-98.7483333	SE	4/18/2007	Irrigation	Groundwater Well	52	7.34902624
110959	Ryan Redgate	36.5255	-98.7466667	SE	4/18/2007	Irrigation	Groundwater Well	57	7.441071896
27919	Robert Corbin	36.5039	-98.708115	SE	2/12/1992	Domestic	Groundwater Well	81	7.490666085
Total Wells Present in Quadrant									**31**
105157	Larry Davidson	36.4539	-98.8116167	SW	9/21/2006	Domestic	Groundwater Well	20	1.782605889
45639	Matt Gard	36.424262	-98.772378	SW	1/28/1998	Irrigation	Groundwater Well	50	1.841102253
174891	Max Redgate	36.456989	-98.77776	SW	5/12/2016	Agriculture (non irr)	Groundwater Well	21	2.475960767
63917	Chesapeake Operating Inc.	36.47846	-98.803534	SW	8/12/2001	Mining	Groundwater Well	20	3.443888426
18643	AMOCO Production	36.431497	-98.732846	SW	5/3/1985	Industrial	Groundwater Well	30	4.020144438
87752	Gene Gard	36.431	-98.729	SW	4/2/2004	Agriculture (non irr)	Groundwater Well	20	4.232512043
87753	Gene Gard	36.431	-98.7287	SW	4/2/2004	Agriculture (non irr)	Groundwater Well	20	4.249195427
107638	Eleanor Holmes	36.3659167	-98.7860167	SW	2/20/2007	Domestic	Groundwater Well	40	4.46819828
18716	Robert Amour	36.453365	-98.728229	SW	3/12/1984	Domestic	Groundwater Well	38	4.600264029
143474	VIC TRAMMELL	36.48537	-98.8651	SW	5/14/2012	Agriculture (non irr)	Groundwater Well	90	5.152853954
92695	G. E. Kenaga	36.5073	-98.7978667	SW	3/8/2005	Mining	Groundwater Well	50	5.452167255
116635	Dale Adkins	36.41742676	-98.70640306	SW	4/21/2008	Domestic	Groundwater Well	20	5.542459627
18714	Triad Drilling	36.470534	-98.719183	SW	1/15/1980	Industrial	Groundwater Well	100	5.583545536
102939	brad hutchison	36.3480167	-98.8122333	SW	7/12/2006	Domestic	Groundwater Well	40	5.59401869
18779	Magic Circle Energy	36.510876	-98.776612	SW	5/20/1981	Industrial	Groundwater Well	78	5.900262039
118798	Brian Henson	36.46100946	-98.70515973	SW	6/30/2008	Domestic	Groundwater Well	80	5.988228477
170949	Joey Miebergen	36.5145049	-98.78972591	SW	12/31/1999	Agriculture (non irr)	Groundwater Well	40.3	5.996540195
170950	Joey Miebergen	36.5145049	-98.78972591	SW	12/31/1999	Agriculture (non irr)	Groundwater Well	40.3	5.996540195
24124	Bob Calvery	36.496557	-98.874338	SW	9/6/1990	Domestic	Groundwater Well	42	6.075928923
121346	Jerry Nickelson	36.5034167	-98.8695167	SW	8/26/2008	Agriculture (non irr)	Groundwater Well	38	6.292758561
48513	Alfred Ball	36.355677	-98.874499	SW	10/13/1999	Domestic	Groundwater Well	80	6.36180659
18718	Bill Munn	36.460573	-98.68809	SW	2/20/1990	Domestic	Groundwater Well	50	6.868713376
32934	Opel Jones	36.478575	-98.697022	SW	7/19/1995	Domestic	Groundwater Well	39	6.927880409
86471	Donald Hull	36.5254	-98.772131	SW	4/29/2004	Domestic	Groundwater Well	50	6.934923436
39067	PEARL CRANE	36.493058	-98.705867	SW	8/15/1997	Domestic	Groundwater Well	60	7.087821897
165611	Zook, Dale	36.5255	-98.7625	SW	1/22/2015	Irrigation	Groundwater Well	48	7.101484498
89798	Ron Bouziden	36.507487	-98.887833	SW	9/2/2004	Domestic	Groundwater Well	35	7.137106561
89799	Tim Warren	36.522032	-98.741682	SW	8/28/2004	Domestic	Groundwater Well	64	7.354641069
Total Wells Present in Quadrant									**28**

Note:
- Information is from the OWRB website: www.owrb.ok.gov accessed September 2, 2020.
- OWRB = Oklahoma Water Resource Board

Table 3.2
Hydraulic Properties of Water-Bearing Units

Water-Bearing Unit	Estimated Hydraulic Conductivity	Well-Yield Range	Approximate Depth to Water
Quaternary Alluvium(*)	---	≤300 gpm	10 – 20 feet bgs
Quaternary Terrace Deposits (*)	---	≤900 gpm	10 – 30 feet bgs
Permian Flowerpot Shale (**)	10^{-6} cm/sec	< 1 pgm	5 – 30 feet bgs
Permian Cedar Hills Sandstone (*)	---	≤600 gpm	30 – 100 feet bgs (in outcrop belt)

(*) – Morton, 1980
(**) – USPCI, 1987
Gpm – gallons per minute
Bgs – below ground surface

Table 3.3
Hydraulic Conductivity Values Summary – Field Testing of Water-Bearing Units

Test Type	Upper Unconfined Aquifer	Upper Unconfined Aquitard	Upper Unconfined Aquiclude	Upper Confined Aquifer	Upper Confined Aquitard
Packer Test	1.62E-05 (19)	5.69E-06 (13)	3.10E-06 (3)	3.35E-06 (2)	1.90E-05 (1)
Pumping Test	*	*	*	6.36E-06 (3)	*
Slug Test	8.66E-06 (17)	1.68E-07 (3)	*	1.44E-05 (2)	*
Horizontal Core Test	1.81E-06 (3)	1.16E-07 (8)	3.38E-06 (2)	3.66E-05 (3)	2.54E-06 (2)
Vertical Core Test	4.45E-08 (3)	3.38E-08 (5)	3.12E-08 (2)	4.81E-05 (1)	1.29E-07 (2)
Test Average for Horizontal Flow	8.89E-06	1.99E-06	3.24E-06	1.52E-05	1.08E-05

Note: The hydrogeologic unites referenced above correlate to historical terminology used for the site.
Refer to Figure 3.12 for cross-referencing to the current Hydrogeologic units.
Hydraulic conductivity units are in cm/sec
( ) – number of values reported

3.2

Groundwater Detection Monitoring Program

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3. GROUNDWATER MONITORING INFORMATION

3.2. GROUNDWATER DETECTION MONITORING PROGRAM

The groundwater detection monitoring well network was modified as part of the May 16, 2019 RCRA/HSWA Permit and post-Closure Permit Modification. This Subsection summarizes the current groundwater detection monitoring program at the facility. This Section is presented in four Subsections: detection monitoring objectives; detection monitoring program description; data analysis procedures; and data reporting procedures.

3.2.1. DETECTION MONITORING OBJECTIVES

The primary objective of the groundwater detection monitoring program at the Lone Mountain Facility, and all other facilities subject to the standards of 40 CFR 264, Subpart, F, is to detect a release to groundwater from the landfill disposal cells. The successful accomplishment of this objective requires that representative groundwater samples be collected from the detection monitoring well network with a regular frequency. The data must then be evaluated using appropriate analytical and statistical methodologies in order to identify a potential release. The specific methods and tools employed by the facility to accomplish this objective, including refinements approved since 2009, are described in detail in this section.

3.2.2. DETECTION MONITORING PROGRAM DESCRIPTION

Sampling and analysis of shallow site groundwater for detection monitoring purposes has been on-going at the facility for its entire operating lifetime. The facility was required to expand its initial groundwater detection monitoring system under the original RCRA/HSWA Permit in 1988. As new landfill cells are constructed, the facility adds additional detection monitoring wells to the system. In addition, wells have been replaced, removed, installed, and changed status as necessary as the site detection monitoring program has evolved.

Over the life of the facility, a total of fifteen (15) landfill cells have been constructed. Currently, Cell 15 is the only operational unit. The remaining cells and certified closed Subcells (Phases I, II, III, and

IV) within Cell 15 are in Post-Closure. For the purposes of detection monitoring, these landfill cells have been organized into Waste Management Areas (WMAs), each of which have defined up- and down-gradient wells for detection monitoring. The down-gradient wells are classified as belonging to specific WMAs, while the up-gradient wells are common to all WMAs. With the exception of the Tetrachloroethene (PCE) contamination first detected in monitoring well MW 5A2 in March 1989 within the Cell 5 area and chlorinated solvents detected in monitoring well MW 4A3(new) in October 2002 in the Drum Cell area, both of which have been addressed (see detailed description in Section 3.3), no other releases from operating or closed landfill cells have been detected by the monitoring network.

The facility submitted two (2) Oklahoma Administrative Code 252:4-7 Tier I and 40 CFR 270.42 Class 2, Operating and Post-Closure Permit Modification Applications to the Oklahoma Department of Environmental Quality (ODEQ) in January 2019. The applications proposed changes to the following Permit sections: RCRA Part B Operating Permit Part V: *Groundwater Detection Monitoring* dated April 1, 2011; *Groundwater Sampling and Field Analysis Standard Operating Procedure* (SOP) dated August 2009; and RCRA/HSWA Post-Closure Permit Modules IV: *Detection Monitoring* and V: *Corrective Action* dated May 21, 2018. The Permit modification requests were approved by the Oklahoma Department of Environmental Quality on May 16, 2019.

There are seven (7) areas of major change to both the Operating and Post-Closure Permits as follows: 1). modified point of compliance; 2). modified monitoring well networks; 3). early detection monitoring and statistical analysis clarification; 4.) removal of constituents from the monitoring program; 5.) the addition of low flow groundwater sampling procedures to the SOP; 6.) reporting timing; and 7.) reduction in the frequency of measuring the groundwater elevation. There are three (3) areas of minor changes to the Permits as follows: 1.) cessation of sampling non-Permit program monitoring wells; 2). vertical construction of monitoring wells as opposed to inclined monitoring well installation for Cell 15; and 3). addition of well and constituent tables within the Permits. The concepts and details of the major and minor changes are uniformly carried through the Operating Permit, Post-Closure Permit, and the Groundwater SOP.

3.2.2.1. Well Locations and Regulated Units

There are currently nine (9) WMAs. These areas include landfill Cells 1 through 8, Cells 10 through 15, and the Drum Cell. With the exception of Cell 15, all cells are in post-closure where groundwater detection monitoring conditions are covered by a separate Post-Closure Permit. The location of all of the above-referenced WMAs in relation to the facility are shown in Figure 3.15: *Detection Monitoring Well Network and Waste Management Areas*.

Historically, with the facility's RCRA/HSWA Permit renewal in 1999, modifications to the detection monitoring well network were made. At that time, the monitoring program was made simpler and consistent with understanding of the groundwater flow environment (refer to Section 3.1.3.2.1). Monitoring wells were classified into two groups for the purposes of statistical evaluation of chemical parameters.

The historical group classification of site wide monitoring wells was based on the hydrogeochemical characteristics of the groundwater. The well group assignments are listed in Tables 3.4a-b: *Detection Monitoring Well Network*. The Group I, hydrogeochemical well group, generally defined as sulfate (SO_4^{2-}) >15% of total anions, corresponds to groundwater of the local flow regime. Groundwater in Group II wells are characterized by chloride being the dominant anion. In 1999 wells screened in the regional chloride-dominated, Group II hydrogeochemical unit, were removed from the detection monitoring program. Exceptions were made to allow for a minimum of three wells down-gradient of each WMA or to allow for two monitoring wells on both the east and north down-gradient sides of the corresponding WMA. When required to fulfill the latter exception, wells within $\pm$ 2% SO_4^{2-} >15% of total anions were chosen to remain within the detection monitoring well network.

As part of the 2019 Permit Modification, the facility redefined the Point of Compliance in both the Operating and Post-Closure Permits Per 40 CFR 264.95(b)(2) which states "*If the facility contains more than one regulated unit, the waste management area is described by an imaginary line circumscribing the several regulated units*" and shift the point of compliance to the downgradient boundary (east side) of the landfill as a whole. The point of compliance is defined in the Permit as "*a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units [40 CFR 264.98(a)]. As the facility contains more than one regulated unit, the waste management area is described by an imaginary line circumscribing the several regulated units [40 CFR 264.98(b)(2)]. This imaginary line is* *defined as the northern and easternmost, hydraulically down gradient, limit of the following landfill cells in order from the north west corner of the landfill wrapping around to the south east corner of the following Cells: Cell 15 future Subcells 15 and 14; Cell 15 Subcells 13, 11, 10, and 8 through 1; Cell 12 and Cell 11. Thence from the south east corner of Cell 11 trending south east to a line that is parallel to and offset 200 feet west of the eastern property boundary. The southernmost segment of the imaginary line lies east of all wells monitoring Cells 8, 6, 5, and the Drum Cell*."

This change also precipitated a shift in the significance of some wells in the program from being Point of Compliance wells to detection only monitoring wells. Further, ten (10) monitoring wells were removed from the program. Moving the emphasis of the monitoring program to the down gradient landfill cells is appropriate due to the exceptionally slow groundwater migration rate of the Flowerpot Shale in which the landfill is situated. The slow groundwater migration rate (see Section 3.1.3.2.1.1) coupled with the rate of natural attenuation of contaminants provides a safety net against contaminants reaching the Point of Compliance. The new point of compliance boundary is approximately 200 feet west of the property boundary at its nearest point. To ensure that potential sources of contamination are caught early and mitigated to prevent contaminant migration to the Point of Compliance, the facility monitors a network of Detection monitoring wells that are monitored in the same manner as the Point of Compliance Monitoring Well network.

The number of Point of Compliance Monitoring Wells in both the operating and Post-Closure Permits in keeping with the redefined Point of Compliance. Both types of monitoring wells are sampled on the same schedule and for the same group of constituents but detects in groundwater collected from Detection Monitoring Wells has a redefined significance. The details of the changes are described below in Section 2.3: Early Detection Monitoring Program & Statistical Analysis. There were no changes to the five (5) upgradient background monitoring wells.

The detection monitoring well network at the Lone Mountain Facility consists of sixty (60) wells. Five (5) of these wells monitor up-gradient groundwater quality while there are twenty-three (23) Point of Compliance; fifteen (15) Detection; nine (9) Corrective Action Point of Compliance; and eight (8) Corrective Action Source Zone monitoring wells utilized to monitor open and closed landfill cells at the facility. The resulting detection monitoring well network is summarized in Tables 3.4a-b. These tables show monitoring well IDs, hydrogeochemistry groupings, screen intervals, location coordinates, as well as associated Point of Compliance Cell numbers and WMA numbers. Landfill Cell 5 monitoring wells that are specific to the Post-Closure Corrective Action program are not included the Operating Permit monitoring well network. The locations of the existing monitoring wells in the detection monitoring system relative to the facility are shown in Figure 3.15 *Detection Monitoring Well Network and Waste Management Areas*. The Figure identifies Point of Compliance wells, Detection wells, and Corrective Action wells. The map is color coded to reflect the type of wells as defined by the 2019 accepted Permit modification.

Herein, a modification of the designation of wells utilized to monitor WMA #4, the Drum Cell, is requested. Currently Section V.B.5.e states "*WMA #4 shall encompass the Drum Cell along the toe of the cell. Monitoring MW 4A1 and MW 4A2 shall comprise the Point of Compliance monitoring wells for the WMA. Monitoring wells CM-9 and CM-10 and MW 4A3(new) shall serve as Detection Monitoring Wells.*". The requested change to the statement is proposed as the following: "WMA #4 shall encompass the Drum Cell along the toe of the cell. Monitoring well MW 4A2 and CM-9 shall comprise the Point of Compliance monitoring wells for the WMA. Monitoring wells MW 4A1, CM-10, and MW 4A3(new) shall serve as Detection Monitoring Wells.". The Drum Cell and this request is described further in Section 3.3: *Summary of Groundwater Corrective Action Program*, below.

In summary the monitoring well network at the facility consists of the following three (3) types of groups of wells: 1.) upgradient wells; 2.) Point of Compliance wells; and 3.) Detection Monitoring wells as follows:

1. Five (5) wells are designated as Upgradient monitoring wells. These monitoring wells are MW 1A, MW 1B, MW 2A1, MW 2B and MW 3A.

2. Currently, twenty-three (23) monitoring wells are designated as Point of Compliance monitoring wells. The Cell designation and wells are listed in the table below.

Drum Cell	~~MW 4A1~~ CM-9 and MW 4A2
Cells 1 through 7	Detection Monitoring Only
Cell 8	MW 8A1, MW 8A2, and MW 8A3
Cell 10	Detection Monitoring Only
Cell 11	MW 11A2 and MW 11A4

Cell 12	MW 12A1 and MW 12B1
Cell 13	Detection Monitoring Only
Cell 14	Detection Monitoring Only
Cell 15	MW 15A1, MW 15A2, MW 15A3, MW 15A4 and MW 15A5, MW 15A6, MW 15A7, MW 15A8, MW 15A10, MW 15A11, MW 15A13A, MW 15A13B, MW 15A13C, and MW

3. The Detection Monitoring Well Network shall consist of the following fifteen (15) monitoring wells listed below:

Drum Cell	~~CM-9,~~ CM-10, MW 4A1, and MW 4A3(new)
Cells 1 through 7	MW 6A1 and MW 6A2
Cell 8	Point of Compliance Monitoring
Cell 10	MW-21 and MW-22
Cell 11	MW 11A5
Cell 12	MW 12B2
Cell 13	MW 13A1 and MW 13A2
Cell 14	MW 14A1, MW 14A2, MW 14B1, and MW 14B2
Cell 15	Point of Compliance Monitoring

3.2.2.2. Monitoring Frequency

All wells in the groundwater monitoring program are to be sampled Semi-Annually. New wells for which total metals data is insufficient to calculate statistics are to be sampled for on a quarterly basis during the first year in order to establish a statistical distribution. A minimum of eight (8) samples are required to perform the calculations. After the initial four quarters of sampling, detection monitoring wells are sampled semi-annually beginning with the first semi-annual event which occurs after waste is first placed in the cell.

3.2.2.3. Analytical Monitoring and Indicator Parameters

The current detection monitoring program in the RCRA/HSWA Permit applies to Cell 15 and is identical to that of the Post-Closure Permit monitoring program. Cells 1-8, 10-14, certified closed Subcells of Cell 15, and the Drum Cell are monitored under the Post-Closure monitoring program. The use of one detection monitoring program reduces confusion and provides consistency between the overlapping detection monitoring programs.

A tabular summary of general chemistry and inorganic laboratory analytical results under the groundwater detection monitoring program at the facility for the time period of April 1999 to April 2020 is presented in Appendix 3.14: *Inorganic Detection Monitoring Results Data Summary (1999-2020)*. Also presented in the summary are basic descriptive statistics for each parameter. Trend plots showing concentration versus time are presented for selected parameters in Appendix 3.15: *Concentration Versus Time Plots (As, Ba, Cr, Pb, Se, Ca, Cl, Mg, Na and SO4)*. These parameters include the eight (8) the indicator metals for which statistics are currently performed (arsenic, barium, beryllium, cadmium, calcium, chloride, chromium, lead, magnesium, mercury, potassium, selenium) plus calcium, chloride, magnesium, sodium, and sulfate. Box and whisker distribution plots for the same list of parameters are presented in Appendix 3.16: *Box and Whiskers Distribution Plots (As, Ba, Cr, Pb, Se, Ca, Cl, Mg, Na and SO4)*. Hydrographs depicting groundwater elevations as a function of time are presented in Appendix 3.17: *Monitoring Well Hydrographs*.

1. *Detection Monitoring Analytical Lists*

The program consists of two lists: one list of inorganic analytes and one list of organic analytes (see Table 3.5a-b: *Detection Monitoring Parameter Lists*). The inorganic compound list consists of the eight (8) indicator metals (arsenic, barium, beryllium, cadmium, chromium, lead, mercury, and selenium) for which statistical analyses are conducted, three gross cations (Na^{+}, Ca^{+2}, Mg^{+2}), and four gross anions (Cl^{-}, SO_4^{-2}, CO_3^{-2}, HCO_3^{-}). The organic compound list consists of two different sub-lists including a short list in the fall and a longer list in the spring (Table3.5b). The short list consists of benzene, ethylbenzene, toluene, and xylene (BTEX). The long list consists of volatile, semi-volatile, and pesticide compounds. New detection monitoring wells are analyzed quarterly for one year for inorganic parameters (Table 3.5a) in order to develop an intra-well statistical background. Only inorganic analytes are required for background statistical analysis in new wells. Analytical methods, detection limits, and other details for the above parameters are listed in the May 16, 2019 Groundwater Sampling and Field Analyses SOP.

2. *Up-Gradient Analytical Monitoring*

Up-gradient detection monitoring wells are analyzed semi-annually for the inorganic parameters listed in Table 3.5a only. There are no potential up-gradient sources of organic contamination at the facility and the background concentration of organic contaminants has been shown to be zero (0). Any detection of organic compounds in down-gradient wells is considered a statistically significant increase.

3. Potential Impacts Resulting from Laboratory Contamination

Laboratory contaminants are commonly encountered as part of groundwater sample analysis. A list of common laboratory contaminants has been compiled based upon EPA SW846 Methodology and is presented in Table 3.6: *List of Typical Laboratory Contaminants*. When potential laboratory contamination to samples is suspected results will be evaluated on a case by case basis to determine whether the occurrence is a result of laboratory contamination or if the analyte is actually likely to be present in the groundwater sample. If it is determined that the detection is due to laboratory contamination, then re-sampling will not be performed.

3.2.2.4. Field Sampling and Analyses Procedure

Field sampling and analyses will be conducted in accordance with the section of the Application entitled *Groundwater Sampling and Field Analyses Standard Operating Procedure* (Groundwater Sampling SOP). The Procedure was prepared in general accordance with the guidelines specified in EPA's 1986 "Technical Enforcement Guidance Document" (TEGD) regarding groundwater sampling and analysis. The Groundwater Sampling SOP was most recently updated in in early 2019 with final acceptance of the document by the ODEQ on May 16, 2019.

3.2.2.5. Well Installation/Maintenance/Abandonment Procedures

Monitoring well installation, maintenance, and abandonment procedures will be conducted in accordance with the Standard Operating Procedure (SOP) attached as Appendix 3.18: *Well*

Installation, Maintenance, and Abandonment SOP. The SOP was prepared in general accordance with the procedures specified in ASTM Method D 5092 regarding well installation and maintenance, and ASTM Method D 5299 regarding decommissioning procedures. Figure 3.16: *Typical Well Construction Diagram* presents a generalized diagram used to display details of well construction.

3.2.3. DATA ANALYSIS PROCEDURES

This section describes the procedures by which groundwater detection monitoring data is analyzed and reported. It is divided into a background description of the geochemical analysis of the groundwater data. A description of the current methods of statistical evaluation of the data is also presented in this section.

3.2.3.1. Hydrogeochemistry Analysis Description

This section provides a description of how the groundwater monitoring program was formed based on geochemistry at the facility and its impact on the resulting groundwater monitoring program. A historical summary of the interpretation of the site hydrogeochemistry and current analysis of the site hydrogeochemistry are provided herein.

3.2.3.1.1. Historical Summary

As mentioned previously in Section 3.1.2.2.4 (Site Lithological Analysis), two different studies were conducted for the Lone Mountain Facility regarding whole-rock analysis of the formations underneath the site. The results of these investigations are presented in full in Appendix 3.3: *Lithological Analysis*. These studies provided data on the presence and concentration of elements and minerals in the formations at the facility, which strongly influence groundwater hydrogeochemistry.

Section 3.1.2.1.4 (Regional Depositional Environment) lists four conditions and/or processes which are thought to have occurred at the site and were conducive to the deposition of the above-referenced elements and minerals: 1) the presence of highly saline water; 2) the influx of fresh water; 3) the marginal marine and/or lagoonal setting; and 4) the semi-arid climate with on-going evaporation. Deposition of the above-referenced elements as clays, gypsum, anhydrite, and siltstone in the original environment was followed in time by consolidation and compaction.

Appendix E-7 of the original Part B Permit application provided an extensive discussion regarding the thermodynamic processes involved in the precipitation of minerals from saline water using seawater as a model. Therefore, that discussion will not be repeated here; however, it is important to note that the evaporites and other minerals and elements present in the Flowerpot Shale are the sources of the elevated salt concentrations present in the site groundwater. Concentration distributions of inorganic parameters from groundwater monitoring data over the history of the facility are presented in detail in the next section (3.2.3.1.2).

The dissolved salt concentrations in the groundwater beneath the Lone Mountain Facility are very high and often exceed that of seawater. The collection of groundwater data sufficient to establish background values for all of the groundwater parameters is required in 40 CFR Parts 264.97, 264.98, and 270.14. This is a relatively simple, straightforward set of tasks in a pristine drinking water aquifer, but becomes very formidable when dealing with a dynamic, supersaturated saline groundwater such as that present at the Lone Mountain Facility. This relatively complex hydrogeochemistry is atypical with respect to the majority of groundwater systems for which the groundwater monitoring regulations in 40 CFR Part 264 were designed. This atypical nature can lead to problems with the statistical analysis of inorganic parameter groundwater monitoring data as part of a detection monitoring system. The approach historically utilized at the facility has been to attempt to define background concentrations in the groundwater up-gradient of the site for statistical comparison to groundwater down-gradient of waste management units. However, due to the dynamic and complex geochemical groundwater system at the site, establishment of definitive background concentrations has been challenging.

Historically, groundwater at the facility has been divided into two different geochemical types for the purposes of statistical analysis of the groundwater detection monitoring data. These two water types are based on the concentration of sulfate relative to other anions. The sulfate concentration (expressed as a percentage of total anions) which is used as the dividing point between the two groundwater types has historically been 15 %. Monitoring wells have been classified into either Group 1 or Group II based on the two water types. As part of the groundwater monitoring program evaluation process, analyses performed in Sections 3.1.2.2.2 (Site Stratigraphy) and 3.2.2.1 (Well

Locations and Regulated Units) are consistent with the historical classification system. Considering this analysis, groundwater in the local flow regime above the First Green Claystone falls into the sulfate group (Group I), while groundwater below the First Green Claystone in the regional flow regime falls into the chloride group (Group II). This classification system proved to be a useful tool in which to group the monitoring wells for the purposes of statistical analysis of the detection monitoring data. This is discussed in more detail in Section 3.2.3.2 below (Statistical Methods), as well as in previous reports (USPCI, 1991, 1992).

The current detection monitoring well network consists primarily of Group I wells, which are of the local flow regime. Monitoring wells in the local flow regime typically have sulfate concentrations greater than 15% of total anions. In the more regionally controlled, confined water-bearing units, chloride concentrations become much more elevated and typically make up over 90% of total anions. For the purposes of detection monitoring, the local flow regime is much more important since any potential release from a WMA will first be detected in the local flow regime above the First Green Claystone.

3.2.3.1.2. Current Analysis

As discussed in the previous section, the dissolved salt concentrations in the groundwater beneath the Lone Mountain Facility are very high and often exceed that of seawater. Chloride and sulfate are the dominant anions, while sodium, calcium, and magnesium are the dominant cations. In general, salinity increases with depth in the Flowerpot Shale.

The historical hydrogeochemical data from monitoring wells at the facility is displayed graphically in several different formats. Appendix 3.15: *Concentration Versus Time Plots (As, Ba, Cr, Pb, Se, Ca, Cl, Mg, Na and SO4)* displays concentration versus time plots for the eight (8) the indicator metals for which statistics are currently performed (arsenic, barium, beryllium, cadmium, calcium, chloride, chromium, lead, magnesium, mercury, potassium, selenium) plus calcium, chloride, magnesium, sodium, and sulfate. These plots illustrate the change in concentration versus time of the selected parameters. Box and whisker distribution plots for arsenic, barium, beryllium, calcium cadmium, chloride, chromium, mercury, magnesium, sodium, lead, selenium, and sulfate are included as Appendix 3.16: *Box and Whiskers Distribution Plots (As, Ba, Cr, Pb, Se, Ca, Cl, Mg, Na and SO4)*. The data is presented by waste management area. These plots show the distribution range of selected parameter concentrations; thereby illustrating data variability by location. Durov plots are presented in Appendix 3.19: *Durov Plots*. The plots summarize the major cations and anions including alkalinity, calcium, chloride, magnesium, potassium, sodium, and sulfate. In addition, specific conductance is displayed opposite the cations and pH is displayed opposite the anions. The plots are useful in visually describing similarities and differences in the major-ion chemistry of a groundwater.

In addition to graphical data summaries, raw data is presented in a tabular format by well in Appendix 3.14: *Inorganic Detection Monitoring Results Data Summary (1999-2020)*. The summary of data includes parameters important in assessing the type and quality of groundwater as well as those historically used for statistical analysis. Parameters summarized include total alkalinity, calcium, chloride, magnesium, potassium, sodium, specific conductance, sulfate, and TDS, and the metals arsenic, barium, beryllium, cadmium, chromium, lead, mercury, and selenium. The minimum, maximum, mean, and median concentrations, as well as the variance and standard deviation are presented for each parameter.

3.2.3.2. Statistical Methods

This section provides a description of the statistical methods used as part of the detection monitoring program. The section includes a description of historical statistical methods as background information and current statistical methods. In order to provide early detection of a release from a WMA, robust statistical techniques are currently used to evaluate groundwater analytical data collected from the site. Due to the highly variable and complex nature of the hydrogeochemistry observed in groundwater collected from the shallow water-bearing units at the site, the statistical methodology is continuously being updated and refined.

3.2.3.2.1. Historical Statistical Methods

Originally, Cochran's Approximation to the Behrens-Fischer (CABF) Student's t-test was utilized at the facility as the statistical method to evaluate groundwater detection monitoring data. At the time of original permitting, this procedure was recommended as part of the RCRA regulations in 40 CFR Part 264. Statistical comparisons using the CABF method were performed between water quality data taken from down-gradient wells and up-gradient (background) wells. Essentially, the CABF method compared the sample mean for each down-gradient well, at a single point in time, with the up-gradient sample mean for all up-gradient wells for all time. However, use of the CABF method resulted in an unacceptably high number of statistical excursions which did not represent a contaminant release to groundwater. This high number of excursions or "false positives" was due to several factors related to the inability of the CABF method to effectively compensate for the dynamic and variable nature of the hydrogeochemistry at the site.

In response to the inappropriateness of the CABF method, alternate statistical methods were investigated starting in 1991. This investigation resulted in the identification of methods that were much more appropriate and effective in accounting for the variability observed in site hydrogeochemistry. The statistical procedures consisted of grouping groundwater detection monitoring wells which have similar hydrogeochemical characteristics and using a three tiered approach where each tier used a single-sided tolerance limit technique. More appropriate indicator parameters (i.e., eight metals) were also identified. In November 1992, these alternate statistical methods were submitted to the ODEQ as a proposed Permit modification. With the Application for Permit renewal in 1999, additional modifications to address limitations to the tiered approach were proposed and the data analysis approach was approved by the ODEQ.

3.2.3.2.2. Former Statistical Methods

The former data analysis approach was to classify down-gradient wells within the detection monitoring well network into an inter-well group and an intra-well group. This classification is based on the historical behavior of indicator metals data for each well. Those wells with constituent variability captured by up-gradient wells were placed in the inter-well group. Conversely, those wells with constituent variability not captured by up-gradient wells were placed in the intra-well group. Appendix 3.15: *Concentration Versus Time Plots (As, Ba, Cr, Pb, Se, Ca, Cl, Mg, Na and SO4)* displays updated concentration versus time plots for selected parameters. These plots illustrate the change in concentration versus time of down-gradient historical data and are displayed by WMA.

Analytical data indicated that the intra-well group of wells had hydrogeochemical characteristics relatively different from the up-gradient wells. As a result, the intra-well group wells had a higher probability of failing the inter-well test. Therefore, this group of wells was analyzed only by an intra-well analysis. This diminished the possibility of a statistical exceedance by random chance alone (false positive).

An inter-well evaluation process was conducted on wells believed to be accurately represented by the background variability. A non-parametric approach was utilized, in which the historic maximum concentration within the background data set was used as the non-parametric tolerance limit. This approach did not assume that the data was normally distributed and was not affected by high rates of non-detects.

For the intra-well calculations, non-parametric tolerance limits were employed for background data sets with detection frequencies of less than fifty (50) percent. Data sets with detection frequencies of fifty (50) percent or greater are candidates for parametric or non-parametric tolerance limits based upon the data distribution. If no detections were recorded in the background data set, then the median detection limit was used as the tolerance limit. All intra-well background data sets were tested for normality and log-normality. Data sets that fit the normal or log-normal distribution allowed for the use of parametric tolerance limits. Conversely, non-parametric tolerance limits were applied when the data distribution did not fit the normal or log-normal distribution.

Detection rates are an important factor in determining the proper statistical methods for evaluation of groundwater monitoring data. Due to the low detection rates encountered for beryllium, cadmium, and mercury, these constituents were statistically-evaluated the same as volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) (i.e., any detection in an intra-well or inter-well group down gradient monitoring well was considered a statistical exceedance). Statistical upper tolerance limits were calculated for the other five (5) indicator metals (arsenic, barium, chromium, lead, and selenium). Since detection rates were generally low for these metals in the up-gradient wells, non-parametric tolerance limits were calculated for comparisons with the inter-well group.

The procedures for applying and calculating tolerance limits was based upon applicable EPA guidance documents, specifically, "Statistical Analyses of Ground-Water Monitoring Data at RCRA Facilities," EPA/530-SW-89-026, and "Statistical Analyses of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance (Draft)," EPA/530-R-93-003. All calculated tolerance limits were based upon a 95% confidence level with 95% coverage. Inter-well tolerance limits were calculated every sampling event. For the intra-well group, normal and non-parametric tolerance limits were calculated and regenerated every 2 years. Detection rates for this group were generally higher; therefore, there were more options for constructing tolerance intervals.

3.2.3.2.3 Evaluation of the Former Statistical Methods

Twenty additional years of analytical data from up-gradient wells has been collected since the issuance of the facility's 1999 Permit. The background data set is well defined and is believed to accurately represent the background variability. An ample amount of data exists showing that the down-gradient wells have a different hydrogeochemistry than the up-gradient wells. Up-gradient wells typically exhibit normal distribution and down-gradient wells typically exhibit log-normal distribution.

Tolerance limits by definition produce 5% false positives. In an event including one-hundred and seventy-two (172) data sets this is 8-9 false positives per event. A combined trend analysis approach would take historical data into account but would not expressly be designed to fail at a given rate. Rather it would produce limits less sensitive to random variations for both gradual trends in the data that lead to an anomaly, and to detect radical deviations.

Overall, it is desirable to minimize the number of statistical comparisons performed on the data in order to reduce the possibility of statistical exceedance by random chance alone. Therefore, an approach was implemented that streamlines the current data evaluation process.

The statistical approach can be further refined to maximize efficiency by conducting intra-well testing of all down-gradient wells and eliminating inter-well testing. The former intra-well tests are good for detection of abrupt changes in groundwater chemistry, but they can be insensitive to slow, systematic changes that may occur over time. Intra-well trend analyses for all down-gradient wells is a more appropriate approach.

3.2.3.2.4 Current Statistical Data Analysis Approach

To address the limitations of the former statistical methods described above, modifications to the statistical approach were proposed in 2009. The revisions provided a more robust statistical analyses and increased the probability of early detection of a potential release from a WMA.

The proposal in 2009 was to eliminate inter-well testing and that intra-well testing should be conducted for all monitoring wells in the groundwater monitoring program. Given the large amount of data now available at the Lone Mountain facility, control chart analysis is a more reliable method than tolerance limit analysis for intra-well testing.

A combined control chart method was adopted which is sensitive to both sudden and gradual changes in groundwater chemistry. Combined Shewart-CUSUM control charts (Lucas, 1982) is a common and widely accepted statistical method for monitoring temporal changes in targeted indicators (quality control). This statistical method combines two (2) traditional approaches to quality control: 1.) the Shewart control chart and 2.) the cumulative sum control chart. The Shewart control chart is a statistical test to determine rapid changes in an indicator and the cumulative control chart is a statistical test to detect gradually increasing trends in an indicator. These techniques have been adapted for groundwater quality monitoring purposes. For a comprehensive description of Shewart-CUSUM control charts please refer to Gibbons, 1994.

The Shewart-CUSUM control chart is constructed in a manner similar to how a moving average is calculated through time. Initially, the first eight (8) concentration values are used as a background data set. Shewart and CUSUM control limits are calculated using the background data set. The next two (2) years of sample constituent concentrations are compared to the calculated control limits. If these measured concentrations were found to be below the respective control limits, the system was deemed to be in "control." Next, these data are appended to the "background" data set and a new set of Shewart and CUSUM control limits are calculated and compared to the next two (2) years of monitoring events. This testing and appending continues until all data has been used. Combined Shewart-CUSUM control charts for analytical data from 2009-2019 at all down-gradient wells are presented in Appendix 3.21: *Control Charts for Detection Monitoring Well Network (2009-2019)*. Control charts are presented for arsenic, barium, chromium, lead, and selenium.

Remnant references to "background" groundwater quality with regard to the installation of new monitoring wells currently exists in the Permit. Specifically the statement made in Section V.C.2.a of the Permit states "*Background groundwater quality for inorganic monitoring parameters or constituents shall be based on data from quarterly sampling of the well upgradient from the waste management units for two (2) years or a total of eight (8) independent samples to be collected a* *minimum of 30 days apart*." For clarity, this statement should be updated to reflect intra-well statistical analysis as follows: "Background groundwater quality for inorganic monitoring parameters or constituents that is compatible with Shewhart/CUSM statistical analysis shall be based on data from quarterly sampling of the well for two (2) years or a total of eight (8) independent samples to be collected a minimum of thirty (30) days apart.".

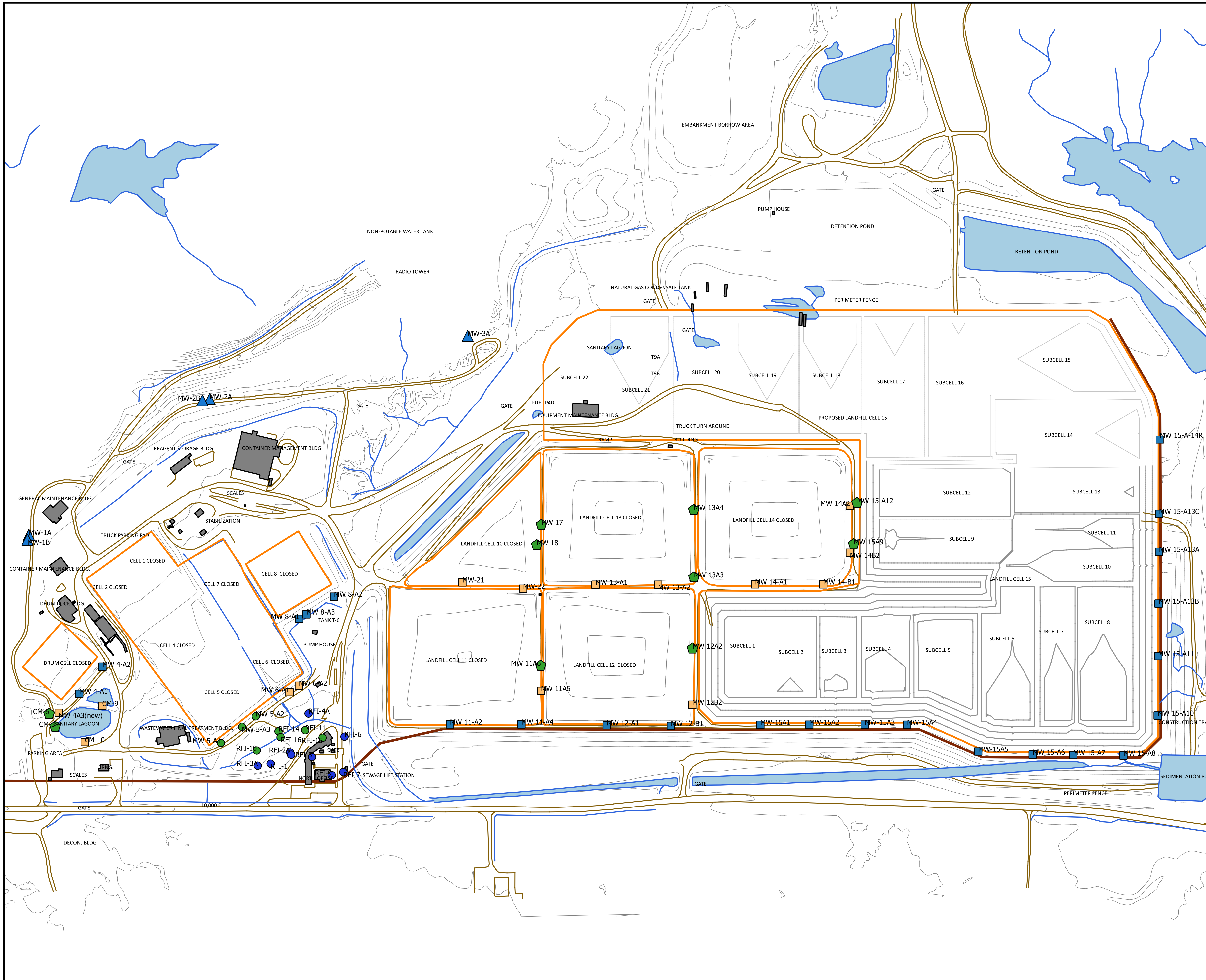
3.2.4. DATA REPORTING PROCEDURES

Sampling and analysis of groundwater for detection monitoring purposes is required semi-annually. The statistical procedures described in Section 3.2.3.2 above are required to assess if there is a statistically significant increase over background for indicator parameters each time the wells are sampled. The sampling event is required to be completed within twenty (20) days of the first day of sample collection. Currently, the analytical and statistical results are required to be submitted to the ODEQ within sixty (60) days after the close of the semi-annual monitoring period.

One of the major changes in the Operating and Post-Closure Permits as of the May 16, 2019 revision is the creation of a "Watch List". A well may be placed on the Watch List in the following two ways: 1.) there is a statistically significant concentration of an inorganic indicator parameter in a Point of Compliance or Detection Monitoring well; and / or 2.) there is an organic detection in a Detection monitoring well. Each of these conditions are described in detail in the next paragraph below. The 2019 Spring Semi-Annual monitoring was the first monitoring period for which the Watch List was implemented.

Prior to the May 16, 2019 Permit modification, the occurrence of a statistically significant concentration of an indicator parameter or an organic detection in any Post-Closure or Open-Cell well in the monitoring program triggered a set of Permit requirements. As was required by the previous versions of the Operating and Post-Closure Permits, Shewhart-CUSUM statistical failures were resampled and if the results of the statistical analysis indicated a Statistically Significant Increase (SSI) in the concentration of one (1) of the eight (8) indicator metals occurred, then 40 CFR § 264.98(g) was to be enacted. This section of 40 CFR is reflected in Operating Permit Conditions IV.E.1 and/or IV.E.2; these sections of the Permit describe the actions to be completed when investigating an SSI. SSI protocol includes DEQ notification, Appendix IX groundwater sampling, and alternate source demonstration or Permit modification requirements. However, under the current (modified) Operating Permit, the statistical analysis is not considered direct evidence of contamination, but rather an indicator of a change in groundwater chemistry. Therefore, Operating Permit Condition IV.E.1 and/or IV.E.2 and Post-Closure Permit Conditions V.F.4 and V.F.5 are not to be enacted without first gathering evidence that an SSI has occurred.

Figures



Legend

N

Legend

- Site Buildings
- Roads
- Point of Complinace
- CA Point of Compliance Well
- CA Source Zone Monitoring Well
- Downgradient Point-of-Compliance Well
- Downgradient Post-Closure Detection Monitoring Well
- Upgradient Well
- Well Removed from the Monitoring Program

Clean Harbors Lone Mountain Facility

Figure 3.15: Detection Monitoring Well Network and Waste Management Areas

Drawn By: AF
LoneMtn.qgs
8/17/2020

Leppert Associates

ENVIROTECH
ENGINEERING & CONSULTING, INC.

PROJECT NAME: Clean Harbors Lone Mountain Facility

Northing:	
Easting:	

MONITORING WELL NO. ____

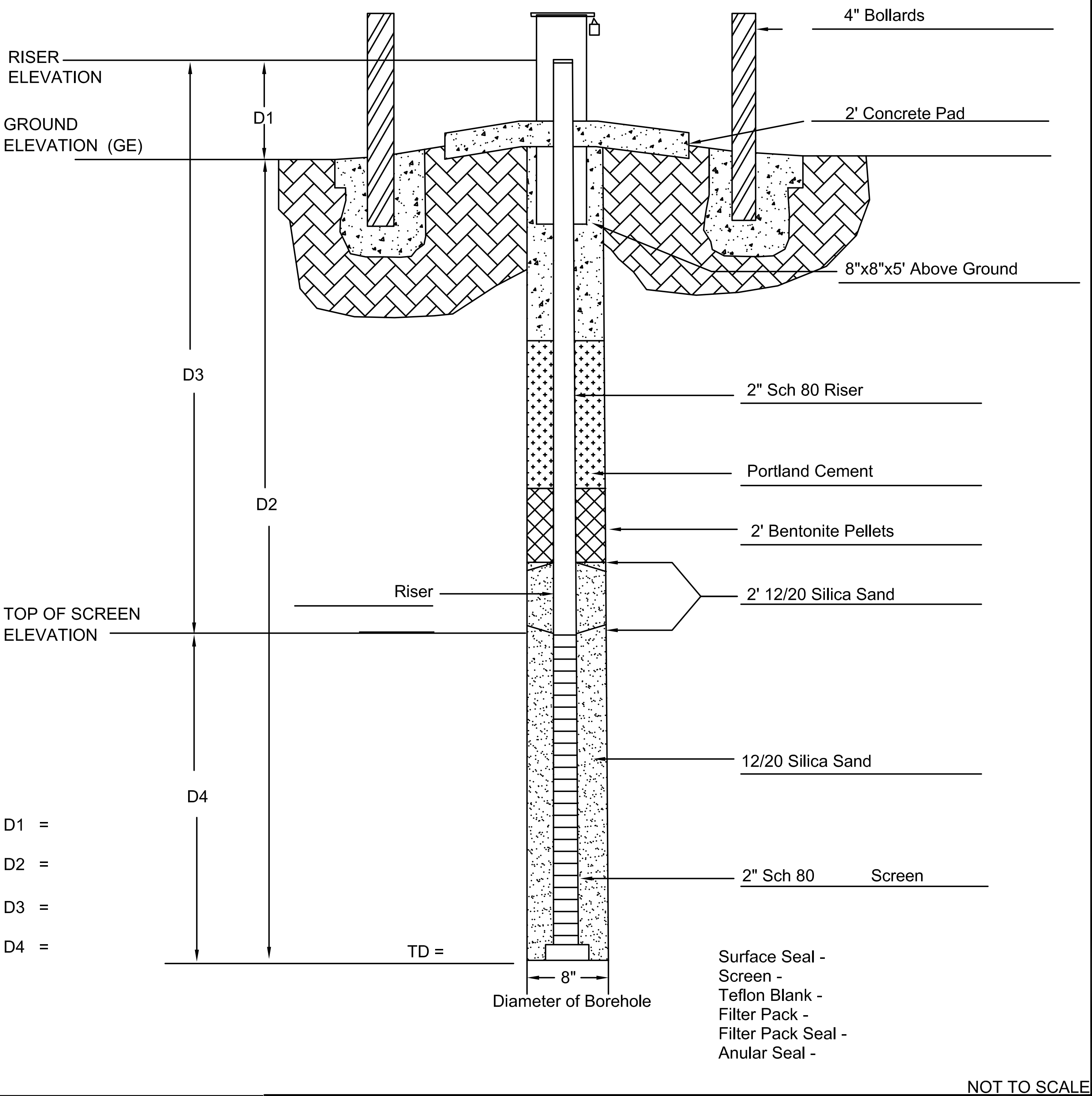


Figure 3.16: Typical Well Construction Diagram

MONITORING WELL INFORMATION

DRILLING CONTRACTOR: ENVIROTECH		DRILLER:
DRILLING RIG TYPE:	DRILL METHOD:	
DATE STARTED:	DATE COMPLETED:	FORM COMPLETED BY:

Tables

Leppert Associates

Clean Harbors Lone Mountain, LLC

Detection Monitoring Well Network Table 3.4a: Up-Gradient Monitoring Wells						Monitored in 2008?	Durov Grouping	Hand Calc Check	Average % SO4 of Anions
Monitoring Well ID	Hydrogeochemistry		Screen Interval	Site Coordinates					
	SO_4^{2-} (Group I)	Cl^- (Group II)		X-Direction	Y-Direction				
MW 1A	✔ ✔ ✔		7-17	10489	8717	x	SO4	SO4	35.9%
MW 1B	✔ ✔ ✔		18-33	10482	8739	x	SO4	SO4	15.6%
MW 2A	✔ ✔ ✔		7-17	11288	8091	x	SO4	SO4	35.7%
MW 2B	✔ ✔ ✔		47-57	11304	8085	x	SO4	Cl	14.2%
MW 3A	✔ ✔ ✔		8-23	12550	7781	x	SO4	SO4	16.0%

Monitoring Well ID	Cell Number	WMA Number	[1]2019 Well Designation	Hydrogeochemistry SO_4^{2-} (Group I)	Hydrogeochemistry Cl^- (Group II)	Screen Interval	Site Coordinates X-Direction	Site Coordinates Y-Direction	Metals Monitored in 2001 9?	Ion Classification
Detection Monitoring Well Network Table 3.4b: Point Of Compliance Monitoring Wells										
[2]MW 4A1	Drum Cell	4	POC	✔1999 ✔2009 ✔2019		14-29	10726	9463	x	SO4
MW 4A2	Drum Cell	4	POC	✔1999 ✔2009 ✔2019		17-32	10834	9336	x	SO4
MW 4A3 (New)	Drum Cell	4	Detection		✔2009 ✔2019	11-26	10628.96	9552.83	x	Cl
[2]CM-9	Drum Cell	4	Detection	✔2019		23.97 - 31.67	10833.50	9520.36	x	SO4
CM-10	Drum Cell	4	Detection		✔2009 ✔2019	7.5-17.5	10751.74	9689.76	x	Cl
MW 5A1	1-7	5	CA Source	✔1999 ✔2009		19-29	11391	9694	-	SO4
MW 5A2	1-7	5	CA Source	✔1999 ✔2009		20-30	11555	9569	-	SO4
MW 5A3	1-7	5	CA Source	✔1999 ✔2009		6-21	11490	9618	-	SO4
MW 6A1	1-7	5	Detection	✔1999 ✔2009 ✔2019		13-23	11713	9456	x	SO4
MW 6A2	1-7	5	Detection	✔1999 ✔2009 ✔2019		3-18	11757	9425	x	SO4
MW 8A1	8	3	POC		✔1999 ✔2009 ✔2019	15-30	11759	9111	x	Cl
MW 8A2	8	3	POC	✔1999 ✔2009 ✔2019		15-30	11922	9007	x	SO4
MW 8A3	8	3	POC	✔1999 ✔2009	✔2019	0-15	11793	9090	x	Cl
MW 11A2	11	1	POC	✔1999 ✔2009 ✔2019		41-56	12467	9607	x	SO4
MW 11A4	11	1	POC	✔1999 ✔2009	✔2019	47-72	12802	9607	x	Cl
MW 11A5	11	1	Detection	✔1999	✔2019	47-62	12894	9449	x	Cl
MW 11A6	11	1	Removed	✔1999 ✔2009		47.4-67.4	12893	9331	-	SO4
MW 12A1	12	8	POC	✔1999 ✔2009 ✔2019		49.5-54.5	13204	9611	x	SO4
MW 12A2	12	8	Removed		✔1999 ✔2009	50-65	13606	9251	-	SO4
MW 12B1	12	8	POC	✔1999 ✔2009	✔2019	54.5-74.5	13505	9614	x	Cl
MW 12B2	12	8	Detection	✔1999 ✔2009	✔2019	55-75	13605	9515	x	Cl
MW 13A1	13	6	Detection	✔2009		40-55	13150	8951	x	SO4
MW 13A2	13	6	Detection		✔1999 ✔2009 ✔2019	50-65	13444	8951	x	Cl
MW 13A3	13	6	Removed	✔1999 ✔2009		50-65	13613	8916	-	SO4
MW 13A4	13	6	Removed	✔1999 ✔2009		40-55	13612	8599	-	SO4
MW 14A1	14	9	Detection	✔1999 ✔2009 ✔2019		49-59	13899.76	8949.25	x	SO4
MW 14A2	14	9	Detection	✔1999 ✔2009 ✔2019		48.5-58.5	14346.02	8579.89	x	SO4
MW 14B1	14	9	Detection	✔1999 ✔2009 ✔2019		53.5-68.5	14220	8949	x	SO4
MW 14B2	14	9	Detection	✔1999 ✔2009 ✔2019		53.5-68.5	14346.01	8800.34	x	SO4
MW 15A1	15	7	POC	✔2009 ✔2019		52.5-67.5	13924.71	9608.86	x	SO4
MW 15A2	15	7	POC	✔2009 ✔2019		60.5-70.5	14154.55	9608.26	x	SO4
MW 15A3	15	7	POC	✔2009 ✔2019		58.59-67.3	14415.50	9608.00	x	SO4
MW 15A4	15	7	POC	✔2009 ✔2019		52-67	14614.22	9606.06	x	SO4
MW 15A5	15	7	POC	✔2009 ✔2019		58.5-68.5	14614.22	9608.56	x	SO4
MW 15A6	15	7	POC		✔2019	58-68	15226.136	9742.995	x	Cl
MW 15A7	15	7	POC		✔2019	64.3-74.3	15436.94	97744.52	x	Cl
MW 15A8	15	7	POC		✔2019	57-67	15624.56	9743.66	x	Cl
MW 15A9	15	7	Removed	-	-	-	-	-	-	-
MW 15A10	15	7	POC	✔2019		62-72	15799.37	9500.09	x	SO4
MW 15A11	15	7	POC	✔2019		49-69	15799.5	9278.96	x	SO4
MW 15A12	15	7	Removed	-	-	-	-	-	-	-
MW 15A13A	15	7	POC	✔2019		48.2-58.2	15800.25	8826.62	x	SO4
MW 15A13B	15	7	POC	✔2019		47.8-57.8	15799.71	9049.83	x	SO4
MW 15A13C	15	7	POC	✔2019		53-63	15799.5	8608.8	x	SO4
MW 15A14R	15	7	POC	✔2019		48.3-58.3	Lat: 36.44049	Long: -98.80637	x	SO4
MW 17	10	2	Removed	✔1999 ✔2009		38-53	12896	8670	-	SO4
MW 18	10	2	Removed	✔1999	✔2009	42-62	12857	8765	-	Cl^-
MW 21	10	2	Detection	✔1999 ✔2009	✔2019	44-64	12526	8921	x	Cl
MW 22	10	2	Detection	✔1999 ✔2009	✔2019	39.5-54.5	12810	8970	x	Cl

✔ (yellow) 2019 Permit Designation

✔ (blue) 2009 Permit Designation

✔ (red) 1999 Permit Designation

Note (1) 2019 Well Designation: Well Status per the May 16, 2019 Permit Modification: POC = Point of Compliance; Detection = Detection Only Monitoirng Well; CA Source = Corrective Action Source Zone; Removed = Well is not longer sampled.

Note (2) Clean Harbors Lone Mountain proposes to exchange the Well Designation of monitoirng well MW 4A1 and CM-9. Monitoring well MW 4A1 would be come a Detection monitoirng well and CM-9 would become a Point of Compliance well.

Table 3.5a: Detection Monitoring Parameter List
Spring List of Organic Constituents

Clean Harbors Lone Mountain, LLC

Waynoka, Oklahoma

Parameter	CAS Number	Parameter	CAS Number
Semi-Volatile & Pesticides		**Volatile**	
1,2,4,5-TETRACHLOROBENZENE	95-94-3	1,1,1,2-TETRACHLOROETHANE	630-20-6
1,2,4-TRICHLOROBENZENE	120-82-1	1,1,1-TRICHLOROETHANE	71-55-6
1,3,5-TRINITROBENZENE	99-35-4	1,1,2,2-TETRACHLOROETHANE	79-34-5
1-NAPHTHYLAMINE	134-32-7	1,1,2-TRICHLOROETHANE	79-00-5
2,3,4,6-TETRACHLOROPHENOL	58-90-2	1,1-DICHLOROETHANE	75-34-3
2,4,5-TRICHLOROPHENOL	95-95-4	1,2,3-TRICHLOROPROPANE	96-18-4
2,4,6-TRICHLOROPHENOL	88-06-2	1,2-DICHLOROETHANE	107-06-2
2,4-DICHLOROPHENOL	120-83-2	1,2-DICHLOROPROPANE	78-87-5
2,4-DIMETHYLPHENOL	105-67-9	1,4-DIOXANE	123-91-1
2,4-DINITROPHENOL	51-28-5	2-HEXANONE	591-78-6
2,4-DINITROTOLUENE	121-14-2	3-CHLOROPROPENE (ALLYL CHLORIDE)	107-05-1
2,6-DICHLOROPHENOL	87-65-0	4-METHYL-2-PENTANONE (MIBK)	108-10-1
2,6-DINITROTOLUENE	606-20-2	ACETONITRILE	75-05-8
2-CHLORONAPHTHALENE	91-58-7	BENZENE	71-43-2
2-CHLOROPHENOL	95-57-8	BROMODICHLOROMETHANE	75-27-4
2-METHYLNAPHTHALENE	91-57-6	BROMOFORM	75-25-2
2-NAPHTHYLAMINE	91-59-8	BROMOMETHANE	74-83-9
3,3-DICHLOROBENZIDINE	91-94-1	CARBON DISULFIDE	75-15-0
3-METHYLCHOLANTHRENE	56-49-5	CARBON TETRACHLORIDE	56-23-5
4,4'-DDD	72-54-8	CHLOROBENZENE	108-90-7
4,4'-DDE	72-55-9	CHLOROETHANE	75-00-3
4,4'-DDT	50-29-3	CHLOROFORM	67-66-3
4-AMINOBIPHENYL	92-67-1	CHLOROMETHANE	74-87-3
4-BROMOPHENYL PHENYL ETHER	101-55-3	CIS-1,2-DICHLOROETHENE (DCE)	156-59-2
4-CHLOROPHENYL PHENYL ETHER	7005-72-3	CIS-1,3-DICHLOROPROPENE	10061-01-5
4-NITROQUINOLINE-1-OXIDE	56-57-5	DIBROMOCHLOROMETHANE	124-48-1
ACENAPHTHENE	83-32-9	DIBROMOMETHANE	74-95-3
ACENAPHTHYLENE	208-96-8	DICHLORODIFLUOROMETHANE	75-71-8
ACETOPHENONE	98-86-2	ETHYL METHACRYLATE	97-63-2
ALDRIN	309-00-2	ETHYLBENZENE	100-41-4
ALPHA-BHC	319-84-6	IODOMETHANE	74-88-4
ANTHRACENE	120-12-7	ISOBUTYL ALCOHOL	78-83-1
ARAMITE	140-57-8	METHYL METHACRYLATE	80-62-6
BENZO(A)ANTHRACENE	56-55-3	METHYLENE CHLORIDE	75-09-2
BENZO(A)PYRENE	50-32-8	PROPIONITRILE	107-12-0
BENZO(B)FLUORANTHENE	205-99-2	STYRENE	100-42-5
BENZO(G,H,I)PERYLENE	191-24-2	TETRACHLOROETHENE	127-18-4
BENZO(K)FLUORANTHENE	207-08-9	TOLUENE	108-88-3
BENZYL ALCOHOL	100-51-6	TOTAL XYLENES	1330-20-7
BETA-BHC	319-85-7	TRANS-1,2-DICHLOROETHENE	156-60-5
BIS(2-ETHYLHEXYL) PHTHALATE	117-81-7	TRANS-1,3-DICHLOROPROPENE	10061-02-6
BUTYL BENZYL PHTHALATE	85-68-7	TRANS-1,4-DICHLORO-2-BUTENE	110-57-6
CHLORDANE	57-74-9	TRICHLOROETHENE	79-01-6
CHLOROBENZILATE	510-15-6	TRICHLOROFLUOROMETHANE	75-69-4

Table 3.5a: Detection Monitoring Parameter List
Spring List of Organic Constituents

Clean Harbors Lone Mountain, LLC

Waynoka, Oklahoma

Parameter	CAS Number	Parameter	CAS Number
Semi-Volatile & Pesticides		**Volatile**	
CHRYSENE	218-01-9	VINYL ACETATE	108-05-4
DELTA-BHC	319-86-8	VINYL CHLORIDE	75-01-4
DIALLATE	2303-16-4		
DIBENZ(A,H)ANTHRACENE	53-70-3		
DIBENZOFURAN	132-64-9		
DIELDRIN	60-57-1		
DIETHYL PHTHALATE	84-66-2		
DIMETHYL PHTHALATE	131-11-3		
DI-N-BUTYL PHTHALATE	84-74-2		
DI-N-OCTYL PHTHALATE	117-84-0		
ENDOSULFAN I	959-98-8		
ENDOSULFAN II	33213-65-9		
ENDOSULFAN SULFATE	1031-07-8		
ENDRIN	72-20-8		
ENDRIN ALDEHYDE	7421-93-4		
ETHYL METHANESULFONATE	62-50-0		
FLUORANTHENE	206-44-0		
GAMMA-BHC (LINDANE)	58-89-9		
HEPTACHLOR	76-44-8		
HEPTACHLOR EPOXIDE	1024-57-3		
HEXACHLOROBENZENE	118-74-1		
HEXACHLOROCYCLOPENTADIENE	77-47-4		
HEXACHLOROETHANE	67-72-1		
HEXACHLOROPHENE	70-34-4		
HEXACHLOROPROPENE	1888-71-7		
INDENO(1,2,3-C,D)PYRENE	193-39-5		
ISODRIN	465-73-6		
ISOPHORONE	78-59-1		
KEPONE	143-50-0		
METHOXYCHLOR	72-43-5		
NAPHTHALENE	91-20-3		
NITROBENZENE	98-95-3		
O-TOLUIDINE	95-53-4		
PENTACHLOROBENZENE	608-93-5		
PENTACHLORONITROBENZENE	82-68-8		
PENTACHLOROPHENOL	87-86-5		
PHENANTHRENE	85-01-8		
PHENOL	108-95-2		
P-PHENYLENEDIAMINE	106-50-3		
PRONAMIDE	23950-58-5		
PYRENE	129-00-0		
TOXAPHENE	8001-35-2		-

Table 3.5b: Detection Monitoring Parameter List
Semi-Annual Inorganic Parameter Monitoring List

(Spring and Fall)

Clean Harbors Lone Mountain, LLC

Parameter	Type	CAS Number
ALKALINITY, BICARBONATE	GC	
ALKALINITY, CARBONATE	GC	
ARSENIC (TOTAL)	RCRA	7440-38-2
BARIUM (TOTAL)	RCRA	7440-39-3
BERYLLIUM (TOTAL)	RCRA	7440-41-7
CADMIUM (TOTAL)	RCRA	7440-43-9
CALCIUM (TOTAL)	GC	7440-70-2
CHLORIDE	GA	
CHROMIUM (TOTAL)	RCRA	7440-47-3
LEAD (TOTAL)	RCRA	7439-92-1
MAGNESIUM (TOTAL)	GC	7439-95-4
MERCURY (TOTAL)	RCRA	7439-97-6
PH, FIELD	Field	
SELENIUM (TOTAL)	RCRA	7782-49-2
SODIUM (TOTAL)	GC	7440-23-5
SPECIFIC CONDUCTANCE, FIELD	Field	
SULFATE	GA	14808-79-8
TEMPERATURE, FIELD	Field	

Table 3.5c: Detection Monitoring Parameter List
Fall List of Organic Constituents

Clean Harbors Lone Mountain, LLC

Parameter	Type	CAS Number
BTEX		
Benzene	Volatile	71-43-2
Toluene	Volatile	108-88-3
Ethylbenzene	Volatile	100-41-4
Xylene (Total)	Volatile	1331-20-7

Table 3.5d: Detection Monitoring Parameter List
Corrective Action List of Constituents

(Spring and Fall)

Clean Harbors Lone Mountain, LLC

Parameter	Type	CAS Number
Tetrachloroethene (Perchloroethylene or PCE)	Volatile	127-18-4
Trichloroethene (Trichloroethylene or TCE)	Volatile	79-01-6
Cis-1,2-Dichloroethene (DCE)	Volatile	156-59-2
Vinyl Chloride (VC)	Volatile	75-01-4

TABLE 3.11
LIST OF COMMON LABORATORY CONTAMINANTS

ANALYSIS TYPE	COMMON LABORATORY CONTAMINANT
Volatile Organics	Acetone
	2-Butanone
	Methylene chloride
Semi-Volatile Organics	Dimethyl phthalate
	Diethyl phthalate
	Di-n-butyl phthalate
	Butylbenzyl phthalate
	Bis (2-Ethylhexyl) phthalate
	Di-n-octyl phthalate

3.3

Summary of Groundwater Corrective Action Program

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3. GROUNDWATER MONITORING INFORMATION

3.3 SUMMARY OF GROUNDWATER CORRECTIVE ACTION PROGRAM

Two closed landfill cells are discussed in this summary of the Corrective Action groundwater monitoring program. Landfill Cell 5 (WMA #5) is part of the Corrective Action program. The Drum Cell (WMA#4) was studied for potential corrective action but groundwater quality did not warrant a separate corrective action program and groundwater monitoring for WMA #4 remained within the Post-Closure groundwater monitoring program. The following subsections present a background summary for both WMAs. Also described are the objectives of Corrective Action monitoring, the groundwater monitoring well network, and the constituents to be analyzed for Cell 5.

3.3.1 THE DRUM CELL

A Drum Cell Corrective Action Feasibility Plan (CAFP) for WMA #4 dated July 2003 was submitted in response to a Statistically Significant Increase of VOCs in MW4-A3 (new) that was detected during the fall 2002 semi-annual groundwater sampling event. In 2005 a delineation study was conducted as part of a Phase I corrective action process as prescribed in the 2003 CAFP. Results of the study were presented to the ODEQ in the Lone Mountain Facility Delineation of the Nature and Extent of Contamination in the Drum Cell Area dated March 11, 2005. The focus of the study was to delineate groundwater contaminants in the area surrounding the down-gradient, northeastern corner of the Drum Cell. Following the delineation study, the Phase II portion of the CAFP was completed and submitted to the ODEQ in the Lone Mountain Facility Drum Cell Migration Potential of Constituents of Concern and Selection of Remediation Alternative Dated November 18, 2005. This corrective action process included the development of a numerical hydrologic model used to develop a conceptual design for groundwater remediation. The selected corrective measures included enhanced leachate collection from the leak detection system and monitored natural attenuation as stated in Section 4.2: Selected CMA Operations of the 2005 Lone Mountain Facility Drum Cell Migration Potential of Constituents of Concern and Selection of Remediation Alternative Report. Institutional controls were initiated to improve the automation of the groundwater extraction system (Leak Detection System) in WMA #4, and prevent the hydraulic head from rising above the base of the cell.

Drum Cell groundwater monitoring conducted under the Post-Closure Permit is conducted as described in Section 3.2.2: Groundwater Detection Monitoring Program, above. Specifically, two (2) POC wells (MW 4A1 and MW 4A2) and three (3) Detection monitoring wells (MW 4A3(new), CM-9, and CM-10) are utilized in the program. Groundwater collected from the wells is analyzed for the standard program list of constituents Semi-Annually. Shewhart/CUSUM statistical analysis of total metals is conducted in addition to monitoring organic results. Upgradient water quality is non-detect for organics and any organic detect is considered a potential SSI requiring further analysis per the Permit. Groundwater elevations are monitored Semi-Annually sitewide and a potentiometric surface is presented annually. Notably, monitoring wells CM-3, CM-6, CM-9, and CM-10 were installed during the Phase II portion of the CAPF as part of a field investigation to provide down-gradient and cross-gradient detection of contaminant migration. These four (4) wells have exhibited consistently good water quality with zero (0) detections of organic constituents since their installation. Monitoring wells CM-3 and CM-6 were removed from the groundwater monitoring program under the May 16, 2019 Permit. The wells are still gauged for water level Semi-Annually.

Currently, during the Spring/April 2020 Semi-Annual groundwater monitoring event, a volatile organic compound was detected in a POC monitoring well within WMA #4. The analytical results from the sampling event were non-detect for one of the two POC monitoring wells (MW 4A2) and two of the three Detection Monitoring wells (CM-9 and CM-10). The constituent 1,1-Dichloroethane was detected in POC monitoring well MW 4A1 at a concentration of 1.2 μg/L. A groundwater re-sample was collected from the well in May 2020. The analytical results of re-sampling the well confirmed the original excursion and a determination was made that an SSI had occurred. The ODEQ was notified of the excursion as an SSI in a letter from the Facility dated June 16, 2020. Per the Permit, Appendix IX groundwater constituent sampling was conducted with non-detect results for all organic constituents in all wells in WMA #4 with the exception of Detection monitoring well MW 4A3(new).

To address the excursion, an Alternate Source Demonstration Letter to the ODEQ dated September 2, 2020 and titled Alternate Source Determination Regarding 1,1-Dichloroethane in Monitoring Well MW 4A1 was developed by the facility. The conclusions made in the letter were based on the results of historical documentation describing water quality, groundwater modeling results using MODFLOW, and selection of remediation alternatives in addition to current groundwater quality sampling and groundwater flow analysis. Several conclusions were made in regard to the results of the Alternate Source investigation conducted by the facility in July 2020. These conclusions are as follows:

- Groundwater in the vicinity of the Drum Cell has been thoroughly studied and an organic plume was delineated in 2005. Monitoring well MW 4A1 is located approximately 25 feet cross-gradient of the plume indicating that the plume is slow to expand due to the slow rate of groundwater flow and the high rate of degradation of the constituents involved. The Point of Compliance is protected from this source of groundwater contamination.

- The groundwater quality of samples collected from monitoring well MW 4A1 has been non-detect for organic constituents until the April 2020 monitoring event.

- There has never been a statistical exceedance in Monitoring well MW 4A1 for any of the eight (8) indicator metals analyzed. Commonly an approaching organic plume is signaled by a change in groundwater chemistry that causes a change in the concentration of Selenium (Total) or Arsenic (Total) in monitoring wells at the CHLM Facility.

- The exact cause of recent detects of 1,1-Dichloroethane in monitoring well MW 4A1 cannot be pinpointed at this time. There are several mechanisms that could possibly lead to migration of the plume or the detections could prove to be anomalous with continued monitoring. Potentially, migration of the plume laterally could be due to a change at the source that occurred long ago, or it could be the result of decades of purging and bringing the contaminant closer to MW 4A1.

- Current analysis of the potentiometric surface in the vicinity of the Drum Cell is in agreement with the conclusions of the 2003 CAFP MODFLOW groundwater simulation of the scenario of pumping the leak detection system with resulting particle tracing showing that groundwater is migrating to the northwest around the Sanitary Lagoon toward monitoring well CM-9.

Considering the conclusions of the investigation, the facility requested approval from the ODEQ to continue monitoring the groundwater quality in MW 4A1 as a Detection Monitoring well for a period of one year before continuing monitoring under standard Permit conditions or making a request to modify the groundwater monitoring program in the Permit to address the excursion. Passing groundwater quality results in MW 4A1 would be required by the 2021 Fall Semi-Annual sampling event. A reply from the ODEQ is pending.

Although the final results of the Alternate Source Demonstration supported continued monitoring of MW 4A1 before making a determination about the status of the well, it is possible that organic detects may continue to occur on an intermittent basis within a short or long term timeframe. Intermittent detects are not definitively an indication that the quality of groundwater at the Point of Compliance is due to become contaminated or that the selected remediation alternative is not performing as anticipated. The selected corrective measures included enhanced fluid collection from the leak detection system and monitored natural attenuation. As demonstrated by daily pumping records, daily fluid removal from the leak detection system is conducted consistently by an automatic pumping system. This fluid, primarily comprised of groundwater, is collected from beneath the Drum Cell and then treated at the Waste Water Final Treatment Plant located onsite. Additionally, the migration potential for contaminants in groundwater in the Flowerpot Shale is very slow in comparison to the rate of natural attenuation of chlorinated solvents. These two components coupled together create a stable plume and resist migration of contaminants thereby protecting groundwater at the Point of Compliance. The Point of Compliance as defined in the Permit is quoted in Section 3.2.2.1: Well Locations and Regulated Units.

Given the extensive knowledge of groundwater behavior in the vicinity of the Drum Cell it is reasonable to conclude that groundwater at the Point of Compliance (located downgradient near the eastern property line of the facility) will remain protected even if the plume has migrated closer to MW 4A1. As such, as stated above, a modification to the designation of wells utilized to monitor WMA #4, the Drum Cell, is herein requested. Currently Section V.B.5.e states "WMA #4 shall encompass the Drum Cell along the toe of the cell. Monitoring MW 4A1 and MW 4A2 shall comprise the Point of Compliance monitoring wells for the WMA. Monitoring wells CM-9 and CM-10 and MW 4A3(new) shall serve as Detection Monitoring Wells.". The requested change to the statement is proposed as the following: "WMA #4 shall encompass the Drum Cell along the toe of the cell. Monitoring well MW 4A2 and CM-9 shall comprise the Point of Compliance monitoring wells for the WMA. Monitoring wells MW 4A1, CM-10, and MW 4A3(new) shall serve as Detection Monitoring Wells.". Any further detections would require that MW 4A1 is added to the Watch List. While on the Watch List, groundwater quality in the well would be monitored for any abrupt changes in the number, concentration, and pattern of detects.

3.3.2 CELL 5

In March 1989, perchloroethylene (PCE) was detected in monitoring well MW 5A2. To investigate this detection, the ODEQ approved an RFI work plan (Geraghty & Miller, 1991) on July 27, 1992. A Phase I RFI report was completed in September 1993 (USPCI, 1993) and a Phase II report was completed in September 1994 (USPCI, 1994). These investigations resulted in the delineation of a contaminant plume in the shallow groundwater.

In September 1995, the Lone Mountain Facility began ODEQ-approved interim measures by pumping contaminated groundwater from monitoring well RFI-14. Following the guidance of the site hydrologic model, a field investigation was initiated and included the drilling of soil borings and additional monitoring wells to determine the optimal location for a pumping well. The investigation identified secondary permeability in the shale that allowed the relatively fast transport of contaminants downgradient of Cell 5. The interim measure was chosen as the corrective measure and continues currently and has continued to be monitored for its effectiveness in creating plume control. Early data showed that by September 1996 pumping had created a groundwater cone of depression around the contaminant plume. Monitoring at that time indicated that the cone of depression at RFI-14 was approximately 15 feet deep and extended laterally to RFI-7 located north of the facility office. In November 1995, an Interim Measures report was completed (USPCI, 1995) and submitted to the ODEQ. On January 3, 1996, the ODEQ determined that the tasks outlined in the RFI work plan were completed and requested that a CMS work plan was submitted. The CMS work plan was submitted on April 5, 1996 and was approved by the ODEQ on May 8, 1996. A Corrective Measures Study Report was completed on November 22, 1996. On January 8, 1998, the Cell 5 Corrective Action Program was incorporated into the facility's Post-Closure Permit. Post-Closure Permit conditions were established for the remedial alternatives and specifics regarding the Cell 5 Corrective Action Program are provided in the Post-Closure Permit.

3.3.2.1 CELL 5 CORRECTIVE ACTION PROGRAM OBJECTIVES

The main objectives and requirements of the Corrective Action Program for the Cell 5 Area are as follows:

1. Conduct Corrective Action to remove or treat in place any hazardous constituents present in the groundwater which are present at concentrations above the groundwater protection

standard between the point of compliance (as defined in the Post-Closure Permit) and the Cell 5 eastern boundary. Pump and treat technology is the designated primary method of remediation for corrective action. Monitoring Well RFI-14 is the designated primary groundwater recovery well to be used to stabilize the plume on-site, by creating a cone-of-influence, while recovery and natural attenuation of contaminants is also occurring.

2. Monitor the contaminant source zone and the associated dissolved plume during the corrective action process to insure containment of any contamination present. This monitoring is accomplished through a network of Corrective Action monitoring wells located within and down-gradient of the plume.

3.3.2.2 SUMMARY OF CORRECTIVE ACTION

Based on the results from the site assessment work, in general, the vertical extent of the contamination in the vicinity of Cell 5 plume is limited to the local groundwater flow regime (groundwater above the Geologic Unit 23 or First Green Claystone). There is also a small localized area of contamination present in the geologic facies just below Geologic Unit 23 in the vicinity of monitoring well RFI-16.

The Cell 5 Corrective Action Program requires three monitoring well zones. According to the current Permit, the Cell 5 Corrective Action Program requires seventeen (17) wells in three (3) monitoring well categories are to be monitored. Monitoring well MW 5A1, formerly a Post-Closure Point of Compliance monitoring well, was moved into the Cell 5 Source Zone category as part of the May 16, 2019 Permit Modification. The Cell 5 groundwater monitoring program wells are described as:

A.) Source Plume: monitoring wells MW 5A2 and RFI-14 (Recovery Well);

B.) Dissolved Plume / Source Zone: monitoring wells MW 5A1, MW 5A3, RFI-10, RFI-11, RFI-15, and RFI-16; and

C.) Compliance Boundary (Point of Compliance): monitoring wells RFI-1, RFI-2A, RFI-3A, RFI-4A, RFI-5, RFI-6, RFI-7, RFI-9, and RFI-17.

Twice semi-annually each well in the Cell 5 groundwater monitoring network is sampled to complete analysis of a short list of VOCs; specifically, Tetrachloroethylene (PCE), Trichloroethene (TCE), cis-1,2-Dichloroethene (DCE), and Vinyl Chloride (VC) by EPA method SW846 8260C. Per Section V.P. of the Permit, the Maximum Concentration Limits (MCLs) for PCE, TCE, DCE, and VC in Point of Compliance wells are 5.0, 5.0, 70.0, and 2.0 μg/L, respectively. Groundwater analytical results for these wells is to be displayed graphically to indicate changes in concentration versus time as required in Post-Closure Permit Sections V.P through V.W of the May 16, 2019 Post-Closure Permit which describes program specific corrective measures, monitoring wells, and data analysis requirements for Landfill Cell 5. See Figures 3.17a-d for illustrations of PCE, TCE, DCE, and VC concentration isopleth maps.

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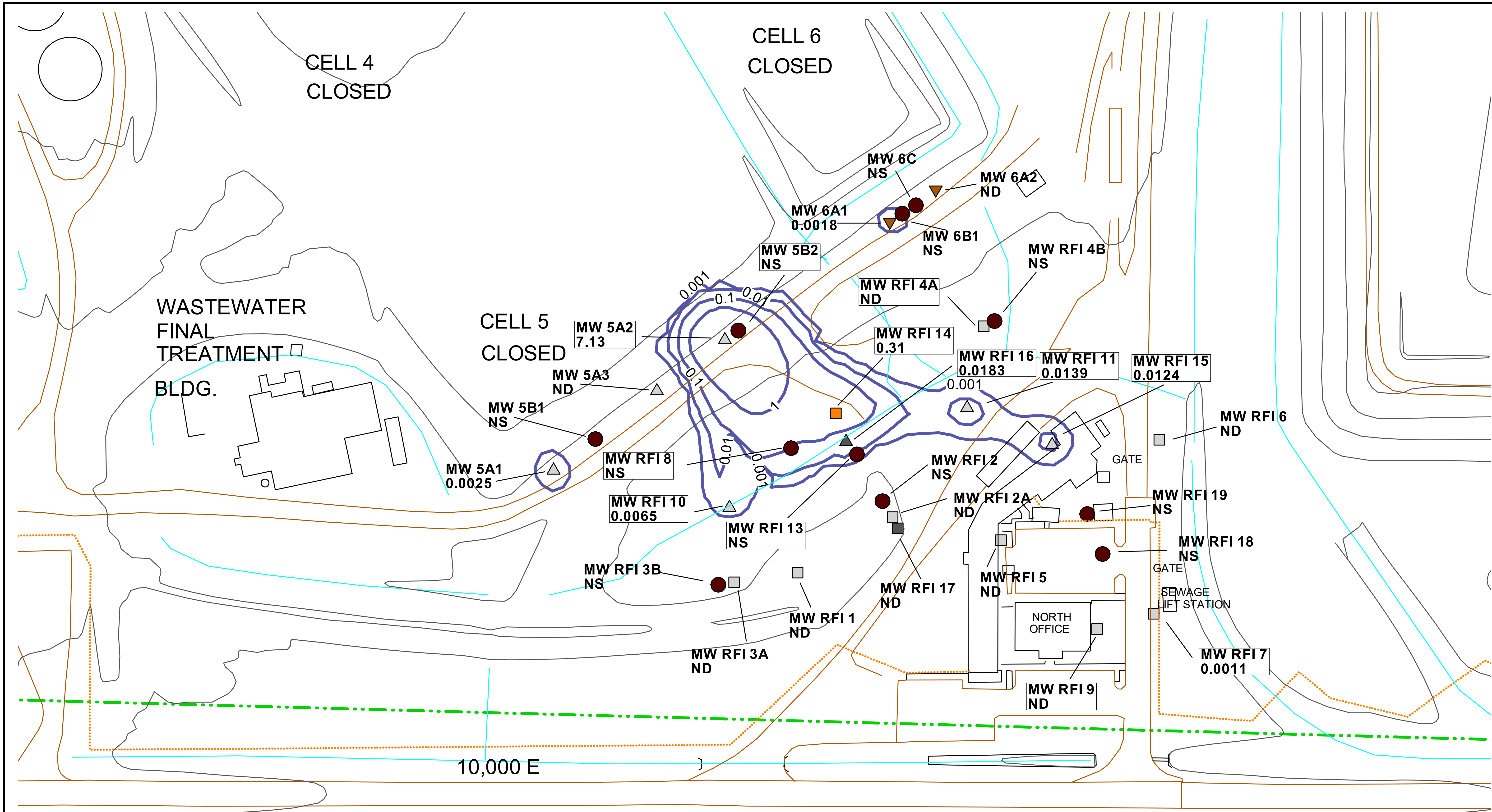
Figures



Legend

Scale:

0 250 500 750

(feet)

N

- Site Surface Feature
  - i.e. - Building, Road, Concrete Pad, etc.
- Fenceline
- Lease Boundary
- Surface Water Feature
- Landfill Cell Boundary
- Site Topographic Features of Interest

2020 Monitoring Well Network

- Cell 5 Deep POC Monitoring Wells
- Cell 5 POC Monitoring Wells
- Cell 5 Deep Source Zone Monitorig Wells
- Cell 5 Source Zone Monitoring Wells
- Other Monitoring Wells
- Detection Monitoring Wells
- Pumping Wells

NS Not sampled

ND Not detected

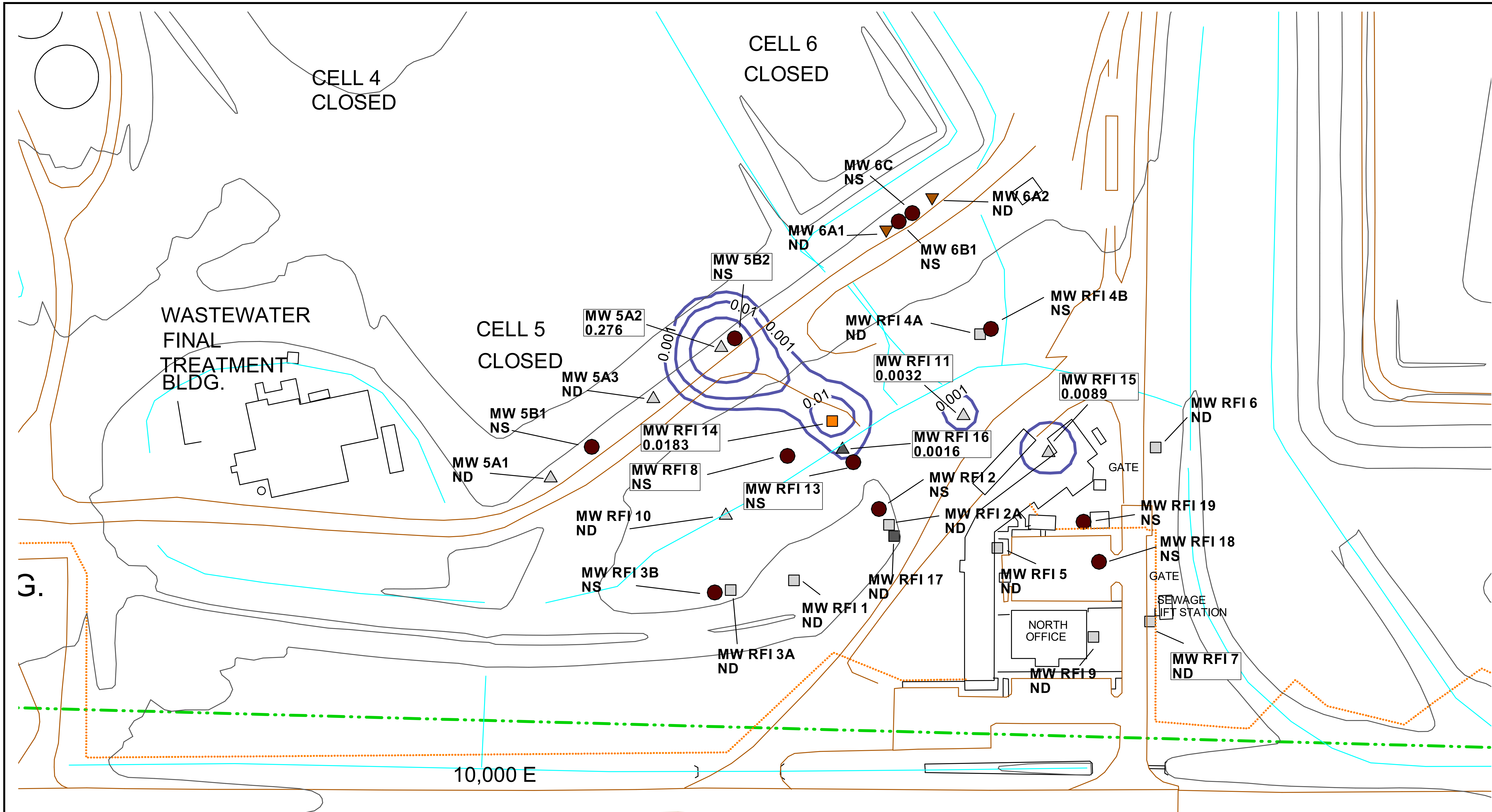
All concentrations in mg/L

Figure 3.17a: Spring 2020 Distribution of Dissolved Phase Tetrachloroethylene (PCE)

Clean Harbors Lone Mountain Facility

Drawn By:
RRR
8/17/2020
Iso-PCE.lpk

Leppert Associates



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Scale:
0 250 500 750
(feet)
N

- Site Surface Feature
  i.e. - Building, Road, Concrete Pad, etc.
- Fenceline
- Lease Boundary
- Surface Water Feature
- Landfill Cell Boundary
- Site Topographic Features of Interest

2020 Monitoring Well Network

- Cell 5 Deep POC Monitoring Wells
- Cell 5 POC Monitoring Wells
- Cell 5 Deep Source Zone Monitorig Wells
- Cell 5 Source Zone Monitoring Wells
- Other Monitoring Wells
- Detection Wells
- Pumping Wells

NS Not sampled
ND Not detected

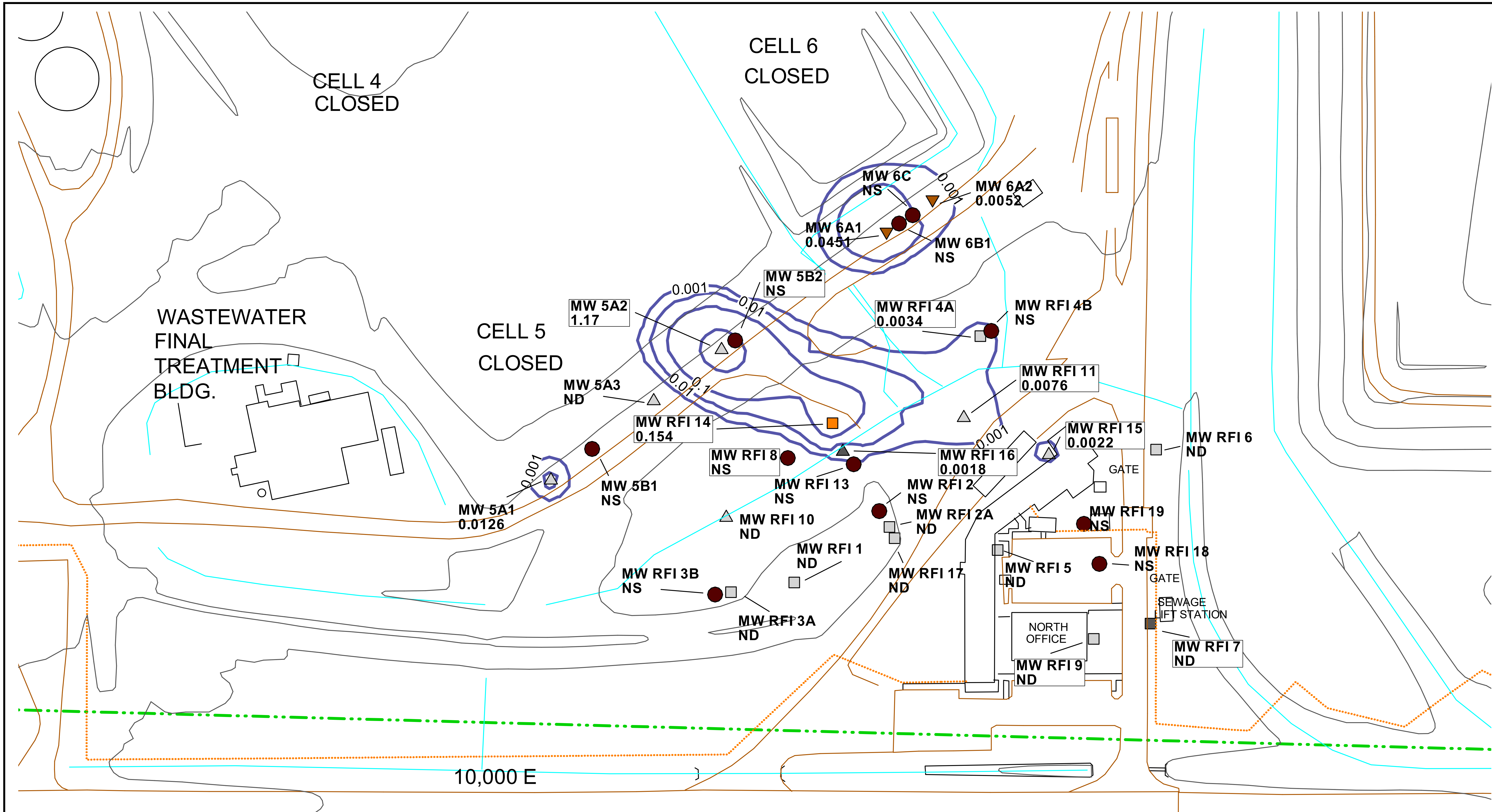
All concentrations in mg/L

Figure 3.17b: Spring 2020 Distribution of Dissolved Phase Trichloroethene (TCE)

Clean Harbors Lone Mountain Facility

Drawn By:
RRR
8/17/2020
Fig6-IsoTCE.lpk

Leppert Associates



Legend

Scale:
0 250 500 750
(feet)
N

- Site Surface Feature
  i.e. - Building, Road, Concrete Pad, etc.
- Fenceline
- Lease Boundary
- Surface Water Feature
- Landfill Cell Boundary
- Site Topographic Features of Interest

2020 Monitoring Well Network

- Cell 5 Deep POC Monitoring Wells
- Cell 5 POC Monitoring Wells
- Cell 5 Deep Source Zone Monitorig Wells
- Cell 5 Source Zone Monitoring Wells
- Other Monitoring Wells
- Detection Wells
- Pumping Wells

NS Not sampled
ND Not detected

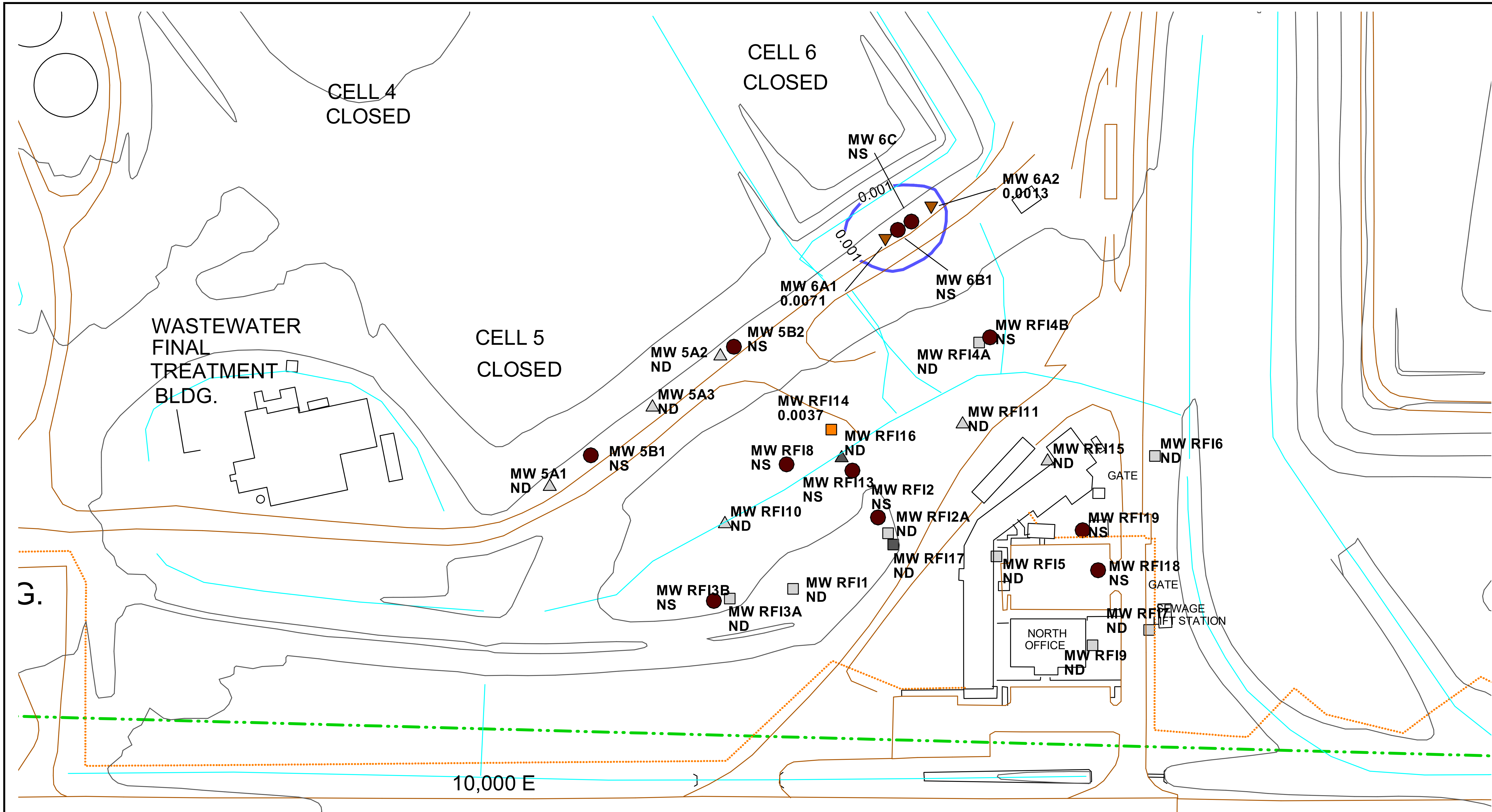
All concentrations in mg/L

Figure 3.17c: Spring 2020 Distribution of Dissolved Phase CIS-1,2-Dichloroethene (DCE)

Clean Harbors Lone Mountain Facility

Drawn By:
RRR
8/17/2020
Fig7-IsoCIS.lpk

Leppert Associates



Legend

Scale:

0 250 500 750

(feet)

N

- Site Surface Feature
  - i.e. - Building, Road, Concrete Pad, etc.
- Fenceline
- Lease Boundary
- Surface Water Feature
- Landfill Cell Boundary
- Site Topographic Features of Interest

2019 Monitoring Well Network

- Cell 5 Deep POC Monitoring Wells
- Cell 5 POC Monitoring Wells
- Cell 5 Deep Source Zone Monitorig Wells
- Cell 5 Source Zone Monitoring Wells
- Other Monitoring Wells
- Detection Wells
- PUMPINGWELLSUPDATE

NS Not sampled

ND Not detected

All concentrations in mg/L

Figure 3.17d: Fall 2019 Distribution of Dissolved Phase Vinyl Chloride

Clean Harbors Lone Mountain Facility

Drawn By:
RRR
8/17/20
Fig8-IsoVC.lpk

Leppert Associates

3.4

Groundwater Sampling and Field Analysis Standard Operating Procedures

Groundwater Sampling and Field Analyses Standard Operating Procedure

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Groundwater Sampling and Field Analyses
Standard Operating Procedure

1 Introduction

1.1 ***GENERAL STATEMENT CONCERNING FACILITY MONITORING***

Protection of the groundwater under the facility is a critical environmental concern of all Clean Harbors Environmental Services, Inc. (CHESI) employees. Whereas all potential contamination of the environment at the facility must be avoided, surface contamination can be cleaned with comparative ease when compared to the difficulty in remediating groundwater. The need for accurate and precise groundwater sampling and analysis is critical. Throughout this section, the term "laboratory" will be used. The “laboratory” is expressly stated to mean a NELAC Certified Commercial Analytical Laboratory.

1.2 ***RESPONSIBILITIES OF KEY PERSONNEL***

Management of the groundwater monitoring program at Lone Mountain will be provided by the facility. There will be a person designated from the facility as the Technical Representative to perform specific duties as noted.

Sampling Teams:

The sampling teams are responsible for the actual field activities of the sampling event. The Technical Representative will act as the team(s) coordinator. Individual team members may come from the Lone Mountain facility, the laboratory, outside contractors, or other appropriately trained persons. The overall strategy for team utilization will be to maximize efficiency and consistency. To this end, the same personnel will normally be assigned specific duties (i.e., purging, sampling, field analyses, and sample preservation tasks). However, alternating the team members is specifically allowed and encouraged. Shifting between tasks allows for training or specific emphasis. Each team member will read this sampling and field analyses plan at least once before participation in their first sampling event. Field experience will be gained in stages, with continuing supervision from one of the senior members of the group. The person(s) responsible for various documents relating to field sampling will become familiar with the SOP and receive instruction from the Technical Representative prior to the event start-up, if necessary.

Team Leader(s):

The Team Leader(s) will be the supervisor for each individual sampling or purge team. Specific responsibilities shall include team adherence to protocol, documentation management for their team, and assignment of team members to specific tasks.

Team Member(s):

These individuals shall accomplish required tasks as assigned by the team leader.

1.3 ***QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)***

Detailed QA/QC procedures are continuously adhered to by CHESI and are a significant part of all aspects of sample collection, sample preservation, sample shipment, analytical procedures, and chain-of-custody control. The procedures and permit application documents address quality assurances and quality controls in the following ways:

- Groundwater sampling and field analyses;
- The analytical detection limits of the constituents shall not exceed the current method detection limits of the appropriate analysis method used to analyze the constituents. A list of

constituent limits is provided in Table 10: Constituent Detection Limits.

- Sample preservation;
- Transportation methods;
- Sample analysis methods; and
- Chain-of-custody procedures.

Examples include the following:

1. CHESI adheres to calibration and maintenance documents from individual manufacturers to assure the proper operation of all equipment. Adjustments, repairs, and corrections are performed as per the vendor's manual.
2. The Lone Mountain Facility conducts each sampling event with several checks for quality.
3. Laboratory blanks are maintained at the analytical facility. Trip blanks are prepared by the laboratory and usually sent with the bottle shipment to the facility and field blanks are collected on site for return to the laboratory (also see Section 3.4 *Duplicate and Blanks Samples*). Equipment blanks are also collected on site and sent to the laboratory. The results of these analyses are used to help determine whether sample contamination originated from a monitoring well or was the result of sampling activities or sample handling or was laboratory induced.
4. Duplicate samples are collected at representative wells and labeled so as to be unidentifiable by the laboratory until document preparation time (these duplicates are identified in the final report as an expression of QA/QC data). See Section 3.4: *Duplicate and Blank Samples* for additional details.
5. Records are prepared to accompany each sample throughout the process.
6. The laboratory evaluates equipment regularly to ensure that calibration checks (e.g., continuing calibration verification) are within method-specified criteria (also see Section 3.4).

7. The laboratory evaluates equipment regularly with duplicates, spikes (if applicable), etc., to assure proper functioning (also see Section 3.4).
8. The laboratory has in place a detailed check and balance system, checking between analyst, supervisor, and manager etc., to further reduce any potential for error. Any laboratory deemed to be qualified will have these or similar QA/QC procedures in place.
9. Quality assurance of the containers used for sampling is also an important element of the QA/QC program. The laboratory will maintain and provide the following information, if requested:
   - Date of bottle preparation.
   - An inventory of the bottles including vendor's name, catalog number, lot number, and bottle description.
   - Date of shipment to the facility, including carrier and handling bill number.

2 Planning the Sampling Event

2.1 ***SCHEDULING***

The final schedule is prepared by the Technical Representative. The schedule will be finalized and confirmed in a cooperative effort between the facility, the laboratory, and the Oklahoma Department of Environmental Quality (ODEQ). The following tasks are normally accomplished in the stated time frames depending on material and personnel availability:

1. Approximately three weeks prior to the beginning sampling date, the bottle order request will be submitted by the facility or its representative to the analytical laboratory.
2. Approximately two weeks prior to the beginning sampling date, appropriate staff from the laboratory and/or the facility

will gather, label, and package the appropriate sample containers for the sampling event. Coolers and containers may be shipped with all other needed sampling or analytical materials.

3. Approximately two weeks prior to the beginning sampling date, the Technical Representative or designee will gather all required instrumentation needed for the field analytical data. This may, if necessary, include:

- Water level indicator,
- Field pH meter and field conductivity meter, and/or
- Flow through cell, and
- Organic Vapor Monitor.

Once the equipment has been gathered, each piece of equipment will be confirmed to be operational by utilizing stated calibration procedures (see Section 2.2 *Day of Sampling Preparation*). As equipment is evaluated, a checklist may be utilized. Any equipment needing repair, recharging, or battery replacement will be evaluated and corrected at this time so all-necessary equipment will be operational during the days of sampling. All standards to be used for the sampling event will be confirmed to be available and in appropriate condition for use during the sampling event. As much as possible, duplicate instrumentation will be available at the facility in case of breakage or malfunction.

4. The sample containers will be inventoried at the facility to assure that all appropriate sample containers have been received in acceptable condition.

5. Approximately one week prior to the start of the sampling event, the Technical Representative, or designee, will assure the other needed equipment is collected:

- Safety equipment including protective gloves, safety glasses, respirators, and chemical resistant coveralls for each team member, as required.
- Wastewater buckets.
- Sample containers for field analytical determinations.
- Deionized/distilled water.
- Well controller for dedicated well pumps. The unit will be confirmed to be working per the manufacturer's specifications.
- Plastic sheets, or other nonporous material (referred to as ground cloths) for use at the individual sampling/well locations. Emphasis is placed on the fact that any surface upon which a sample may be placed should be clean.
- Waste container for purged well water and other water discarded during the sampling event (this water will be appropriately managed).
- Appropriate vehicles.
- Field log. The "field log" shall be kept by the Technical Representative, or designee, as part of the facility sampling records and be a compilation of the field data. The field data will normally be kept on weatherproof pages (e.g., laminated sheets or treated paper). The field data may also be entered into a field computer program. The "field log" may consist of one or more of the following: a) the field data sheets, b) reproductions of portions of individual field books, c) other notes from the sampling event, d) the laboratory notebook, by incorporation, and/or e) any other appropriate field related information. Specific activities will indicate when field notes are to be taken. Information in the log may include, but not be limited to, the following:

- Identification of monitoring well, condition of well, locked or not, any evidence of tampering, and presence of standing water.
- Meteorological information including approximate temperature, wind direction and velocity, barometric pressure, and general conditions.
- Sample team members and any observers.
- Water-well depth information.
- Purging information.
- Specific sampling information for each well.
- Sample distribution.
- Variations from the SOP, if any.
- Notes on any activities occurring near the wells during sampling.

Revisions to the field data sheet may be made from time-to-time as required.

2.2 ***DAY OF SAMPLING PREPARATION***

2.2.1 FIELD INSTRUMENTATION VALIDATION

Field instrumentation will be validated per manufactures' instructions prior to use in the field. If the equipment is rented, it will arrive calibrated by the supplier and ready for use. A copy of the calibration sheet, as provided by the supplier, will accompany the equipment. Calibration standards will also be provided by the supplier. During the event, the equipment will be re-calibrated each day before field activities commence, following the manufactures guidelines for each instrument type. During cold weather events, the equipment will be brought inside a building and not left in vehicles overnight, as prolonged exposure to cold could interfere with the calibration of the equipment. The following equipment requires calibration:

- Flow through cell: This instrument includes measurements for pH, conductivity, temperature and Dissolved Oxygen (DO).
- Turbidity Meter
- Water level meter
- Organic Vapor Monitor (OVM): The OVM will be calibrated using the manufacturer's specifications. Typical analyzers may include a photoionization detector, such as a HNU or OVM, or a flame ionization detector, such as a CGI, TLV, or Foxboro OVA.

2.2.2 HEALTH AND SAFETY

Prior to use, each piece of safety equipment will be checked for appropriate fit and applicability. Other health and safety considerations will be observed in accordance with the facility health and safety requirements.

- Respirators should be of the appropriate type as designated by safety requirements and/or the facility safety representative.
- Protective gloves and chemical resistant coveralls (if required) will be changed as necessary to prevent cross contamination, maintain cleanliness, and to assure safety. At a minimum, gloves will be changed between wells. Gloves should also be worn when handling any items or equipment that may come in contact with groundwater or a groundwater sample. Chemical resistant coveralls will be required only where facility rules or conditions dictate.
- In the event that an OVM reading in the breathing zone of any monitoring well or observation well exceeds 2 parts per million (ppm), all personnel are to promptly leave the immediate area until they have donned the proper respiratory protection. In addition, the Technical Representative will be notified prior to any one reentering the area. Additional efforts to sample

the well will only be made under the direction of the Technical Representative.

2.2.3 SAMPLE CONTAINERS AND COOLERS

Prior to leaving for the field, recheck sample containers to assure that there is a full set for each well, properly marked and labeled. Ice, or other cooling agents, will be added to the coolers to aid in preserving the samples.

2.2.4 DOCUMENTATION PACKAGE

The required documentation package will confirm readiness for the sampling event as per the following inventory list.

- "Measurement of Groundwater Levels" form or equivalent.
- Laboratory or field notebook or field data sheet for field analytical data: pH, conductance, and temperature.
- Field data sheets.
- Chain-of-custody forms.
- Appropriate writing tools, such as indelible markers, will be included as part of the needed documentation package.

2.2.5 VEHICLE USE AND PACKING

The designated vehicles to be used for the sampling event will be loaded so that each item of equipment is readily available. Vehicle inventory may include:

- Sample coolers;
- Field analytical instrumentation;
- Wastewater bucket(s) for purging;
- Interface Probe;
- Deionized water for field blanks, trip blanks, etc.;

- Deionized/distilled rinse water for decontamination;
- Preservatives for samples as back up to laboratory preserved bottles;
- Well pump controller;
- Spray bottles for rinse water if desired and;
- Sample containers.

3 Sampling Plan

3.1 ***MONITORING WELLS***

The monitoring wells to be sampled during each semi-annual groundwater monitoring event are listed in the following two tables:

- Table 4: *Operating and Post-Closure Groundwater Monitoring Wells*
- Table 5: *Corrective Action Groundwater Monitoring Wells*

3.2 ***MONITORING CONSTITUENTS***

The list of constituents in groundwater to be analyzed in the laboratory changes on a semi-annual basis and differs between well type groups. The constituents to be analyzed are listed in the following four tables:

- All monitoring wells in the Operating and Post-Closure programs listed in Table 4: *Operating and Post-Closure Groundwater Monitoring Wells* are monitored for the constituents listed in Table 6: *Inorganic Parameter Monitoring List (Spring and Fall)* during both the Spring and Fall events.

- All monitoring wells in the Operating and Post-Closure programs listed in Table 4: *Operating and Post-Closure Groundwater Monitoring Wells* with the exception of the five (5) Upgradient Wells (MW-1A, MW-1B, MW-2A1, MW-2B, and MW-3A) are monitored for the constituents listed in Table 7: *Spring List of Constituents* during the Spring semi-annual monitoring event each year. These constituents are in addition to the constituents listed in Table 6.
- All monitoring wells in the Operating and Post-Closure programs listed in Table 4: *Operating and Post-Closure Groundwater Monitoring Wells* with the exception of the five (5) Upgradient Wells are to be monitored for the constituents listed in Table 8: *Fall List of Constituents* during the Fall semi-annual monitoring event each year. These constituents are in addition to the constituents listed in Table 6.
- All monitoring wells in the Corrective Action program listed in Table 5: *Corrective Action Groundwater Monitoring Wells* are to be monitored for the constituents listed in Table 9: *Corrective Action List of Constituents* on a semi-annual basis during both the spring and fall events.

3.3 ***ROUTE AND STRATEGY***

The sampling route will be based on purging and sampling the wells with the least potential of contamination first and progressing to the wells with the highest potential for or actual contamination. The basic strategy is that upgradient wells be sampled prior to downgradient wells. If leachate sumps are to be sampled, they will be last on the schedule. Wells known to be slow to recover will be purged at an appropriate time to assure recovery and timely completion of the sampling event. Based on this strategy, a route plan for the sampling team can be developed. The route may change based upon operational requirements or other conditions such as additions in the number of wells, deletion of wells, or, as with Cell 5, one or more wells that are contaminated. An example of the current route schedule is shown on Table 1: *Preferred Sampling and Purging Route*, attached.

3.4 ***DUPLICATE AND BLANK SAMPLES***

Approximately five percent (or one out of twenty) of the wells, rounded to the nearest whole number (e.g., 61 wells rounded to 3), or a minimum of one per day, whichever is more conservative, will be designated for duplicate sample collection. The well(s) chosen for duplicate sample collection will generally be from a group of better recovering wells, capable of yielding two complete sets of samples. Normally, one or more set(s) of duplicate samples will be taken down gradient from open cells and another set of duplicate samples down gradient from closed cells. Upgradient wells may also be selected for duplicate samples. Special field circumstances, laboratory needs, or splitting of samples with regulatory agencies (ODEQ) may require collection of other duplicate and/or QA/QC samples.

In cases where ample water volume is expected, duplicate samples will normally be taken by filling one analyte bottle from the well, and then, an additional analyte bottle of the same type will be filled for the duplicate sample. Each duplicate sample will be marked to disguise the sampling location so that laboratory personnel will not be able to identify the well. Such designations as Duplicate A, B, etc. will generally be used. The Technical Representative will maintain the identity and inform the laboratory during the preparation of the final report as to the identity of the duplicate(s).

In cases where insufficient water volume is expected and samples will be collected by the ODEQ, the agency samples will be collected after the samples have been collected for the facility.

As determined by the Technical Representative, additional field blanks may be collected from any location considered to have a possibility for airborne contaminants that could adversely bias a groundwater sample collected during the sampling event. Duplicate samples will be analyzed for all methods including inorganic (e.g., metals, anions, etc.) and organic parameters.

Field blanks will be collected with the same care and at the "same" time as regular samples. Field blank samples will be analyzed for volatiles and the eight (8) indicator metals, and one (1) sample will be collected for each full day of field sampling. The team leader or Technical Representative will be responsible for selecting the location and time.

An equipment blank will also be collected with the same care as a regular sample. Equipment blank samples will be analyzed for volatiles and the eight (8) indicator metals, and one (1) sample will be collected for each full day of well sampling. The equipment blank samples will be taken in the field immediately before a "clean", non-dedicated piece of equipment (e.g., water level meter) is inserted into the monitoring well. Deionized/distilled water will be placed on or in the non-dedicated piece of equipment, with the water being collected and sent to the laboratory for analysis.

The trip blank samples sent from the laboratory for each event will be returned to the laboratory for analysis. One trip blank sample will be included with each shipment cooler containing VOC samples and analyzed for VOCs only.

4 Purging and Other Specified Well Activities

4.1 ***WATER LEVEL READINGS***

Water level readings for each well can normally be taken using an electronic water level meter. Water levels will typically be measured semi-annually or as required by regulations or permits. Water level measurements are obtained from all wells before groundwater extraction or sample collection is initiated. The Technical Representative, or trained facility representatives, will take the semi-annual measurements during sampling events. Water-level readings are obtained in concert with review of each well using the following order of activities:

1. After arrival at the well, the date, time, *ambient temperature, *wind direction *wind speed, and *barometric pressure (*recorded at least once per day from facility information), and individual(s) present will be recorded on either a field data sheet or team field log book. Other information to be included in the field log can include, but not be limited to, any abnormal condition of the well, such as the well being unsecured or tampered with, degradation of the apron, and the presence of standing water at or near the well, or activities occurring near the well which could potentially impact the samples (e.g. emissions from vehicles operating nearby).

Note: Clean gloves will be worn when performing the following activities.

2. A team member will remove the lock and open the protective casing cover. After ensuring that the top of the well cap is clean, either unscrew the plastic plug or pull out the sampling tubing in the well cap, taking care that no dirt or foreign matter is dropped into the well. After removing the

casing cover, a check of the well head will be taken next and the OVM reading will be recorded on the field data sheet or in the field log book. A reading greater than 2 ppm in the breathing zone will invoke the safety consideration identified in Section 2.2.2 *Health and Safety*.

Water level readings will be measured from the reference "tick-mark" identified on the well cap or well casing if no cap is present. The appropriate team member will wipe the probe of the electronic depth meter with a clean Kimwipe® (or other such disposable material) moistened with deionized/distilled water. Make sure that the cable is clean at all times. Slowly lower the water level probe into the well until the meter indicates that water has been reached. Note the depth at which the water was encountered. Raise the probe until it is no longer in the water. Lower the probe again until the meter indicates that water has been reached and enter this value in the field log book or field data sheet. Field conditions may require variations from this procedure; if so, they will be noted. The meter should be read to the nearest 0.01 ft.

3. Thoroughly wipe both the probe and cable with a Kimwipe® (or other disposable material) moistened with deionized/distilled water as the probe is being removed from the well.

4. Secure the well so the team can then proceed to the next well.

4.2 ***WELL PURGING***

The SOP was revised to incorporate changes to the sample purging and collection method. A low-flow approach utilizing a dedicated submersible pump is the primary purging and sample collection method, replacing the bailer approach previously used. The bailer approach has been retained as a secondary purging and sample collection method. Procedures for both approaches are provided in the following subsections.

4.2.1 GENERAL PROCEDURES

1. Whenever a well is purged, new, clean gloves shall be worn, and a ground cloth will be in place on the well apron.

2. After removing the casing cover, a check of the well head will be taken next and an OVM reading will be recorded on the field data sheet, in the field log book, or electronic log. A reading greater than 2 ppm in the breathing zone will invoke the safety consideration identified in Section 2.2.2.

3. Determine the volume of purge water to be removed from the well based on the purge technique to be utilized.

4. When utilizing low flow sampling technique and encountering dry wells and nearly dry wells See Section 5 *Dry and Nearly Dry Wells*, below.

5. Complete purging the well according to the preferred method per the instructions provided in Sections 4.2.2: *Primary Method - Low Flow Purging* and 4.2.3: *Secondary Method –Purging with a Bailer*.
   a. Note the amount of water removed from the well on the field data sheet.
   b. All purged water will be placed in a waste container and initially treated as hazardous waste if there is an indication of potential contamination based on OVM readings from the well-head. If there is no indication

of potential contamination based on the OVM, purge water and sample water will be treated as non-hazardous waste.

c. If the dedicated pump is non-operational and it cannot be repaired in a timely manner, a replacement pump may be installed or the well may be bailed using the procedures outlined in Section 8: *Observation Wells or Malfunctioning Monitoring Wells*.

At the conclusion of purging or sampling (as applicable):

d. If the well is part of a continuous purge and sample operation, proceed with sampling per Section 5.1: *Low Flow Sampling*. Otherwise, cap and relock the well and proceed to the next well according to the schedule.

f. Dispose of investigation derived waste including the ground cloth, gloves, and any other disposable materials, in an appropriate manner.

4.2.2 PRIMARY METHOD – LOW FLOW PURGING

The primary method for purging and sample collection is a low flow technique. Low flow purging and sampling is a sampling technique that allows for the collection of representative groundwater samples from the adjacent formation surrounding the screened section of the monitoring well. Low flow refers to the velocity with which the water enters the pump intake from the surrounding formation in the immediate vicinity of the well screen. The flow rate of the water, which is subsequently discharged at the ground surface, can be controlled by flow regulators or restrictions. The objective is to minimize drawdown of the water column in the well, avoid disturbance of the stagnant water above the well screen, and draw fresh water through the screen at a rate that minimizes sample disturbance. After drawdown has stabilized and indicator parameters have stabilized, water in the screen can be considered representative of water in the formation. By using this method, the sediment around the well is less disturbed and purging is kept to a minimum.

Pumps with adjustable rate controllers will be utilized for low flow purging and sampling of the monitoring wells at the Site. The monitoring wells are typically two (2) inches in diameter with total depths that range from 16 to 83 feet.

If used, non-dedicated pumps will be decontaminated thoroughly before the first well is purged, and between uses at each well. New tubing will be attached to the pump before extraction and sampling activities commence at each well location. Pump placement and purging will be conducted according to the following steps.

1. If using a non-dedicated pump, thoroughly decontaminate the pump and auxiliary equipment before use at each well.

2. Measure and record the water level in the well immediately before replacement of the pump.

3. For non-dedicated pumps: Before pump placement, attach new tubing to the pump for groundwater extraction and sampling activities. Two types of tubing will be used with the submersible pump to extract and collect groundwater from the wells. To extract the groundwater, Low Density Polyethelene (LDPE) tubing will be connected to the pump and lowered inside the well. A second, more flexible sterile silicone medical tubing will be connected to the other end of the pump and will run out of the well. Connect the dedicated (typically ½ inch) or new silicone tubing to the flow-through meters used to collect the samples. An alternate fluorocarbon or fluorocarbon polymer-lined polyethene tubing may also be used in conjunction with the pump.

4. For non-dedicated pumps: Place pump with attached tubing at the center of the screened section of the monitoring well.

5. To begin purging, the pump should be set at the lowest speed setting, and adjusted to slowly increase until water begins to discharge. Adjust the pumping rate of the submerged pump so that it does not exceed 100 milliliters per minute. Ideally, the flow rate of water from the pump will be approximately the same or less than the water entering the well from the surrounding formation. Check the water level and slowly adjust the pump rate until there is little or no draw-down, or the draw-down has stabilized. To minimize disturbance, pumping rate adjustments should be made within the first fifteen minutes of purging.

6. Document stabilization of the pumping rate. Every three to five minutes, monitor the water level in the well. Under ideal conditions, in order to avoid drawing stagnant water into the pump, the water level should not exceed the distance between the top of the well screen and the pump intake. Therefore, the water level in the well should not fall to the pump intake level. If the static water level is above the well screen, the water level should not fall below the top of the screen.

7. Record indicator parameter measurements (pH, specific conductance, temperature, and turbidity) frequently, at least three to five minutes apart. Use hand held meters with flow through cells.

Indicator parameters will be considered stable when at least three consecutive readings have stabilized as summarized below:

- pH ± 0.2 Standard Units (Note: this measurement may not always be obtainable. Therefore, professional judgment must be used.)
- Specific Conductance: ± 3%
- Turbidity: ± 10% (When > 10 NTUS) maintained at <10 NTUS, considered stabilized
- Temperature: ± 0.5° Celsius

The drawdown in the well may be considered stabilized and sampling may commence when at least three (3) sets of parameters have stabilized.

4.2.3 SECONDARY METHOD – PURGING WITH A BAILER

Although the low-flow approach is the primary method for purging the groundwater monitoring wells, the bailer approach is used as a secondary, back-up method to purge wells and collected samples. The bailer approach may be used if the low flow approach is not feasible, such as if the pump apparatus fails to operate. The bailer method is also used if observation wells are to be sampled, as described in Section 8 *Observation Wells or Malfunctioning Monitoring Wells.* The traditional bailer strategy for purging a well was normally based on removing approximately three well casing water volumes prior to taking any sample for analysis. This volume in the well can be determined by multiplying the water column height in the well by the volume per unit length of the well, as described below.

Slow recovery wells (i.e., three volumes cannot be removed without interruption) will require special considerations. These wells will be purged "dry" and allowed to recharge for approximately twenty-four hours prior to sampling, as detailed in Section 4.2.4 *Dry and Nearly Dry Wells* and Section 5.2 *Delay of Sample Collection*.

Well Volume Calculations for Bailer Purging Method

The volume of water to be removed from the well for purging can be calculated from the following formula:

V = (TWC-DTW)*(3)*(0.1534)

Where:

V = Volume to be removed in gallons

TWC = Length in feet from top of well casing to bottom of well casing

DTW = Depth to water in feet from top of well casing

The formula is based on three well casing water volumes and the fact that for polytetrafluoroethylene (PTFE) "two-inch" pipe in the screened interval, there are 0.1534 gallons per foot of pipe. This is because the actual diameter of PTFE is less than two inches. The formula is changed to 0.65 from 0.1534 on the wells with four-inch inside diameter (ID) pipe. An alternate calculation to record the volume in liters may be made by multiplying the above answer by 3.785 (liters/gallon), or 0.556 liters per foot of pipe. The multiplier will be 0.1743 instead of 0.1534 if the inside diameter is actually 2.0 inches. Two-inch PVC pipe will generally use a 0.1743 multiplier. The proper multiplier has been determined and recorded for each well to be purged.

After the water volume to be removed is calculated for the well, the following protocol is used to purge each well.

a. Prepare the work area for purging as described above under Section 4.2.1 *General Procedures*.

b. Purge the wells as described in Section 8 *Observation Wells or Malfunctioning Wells*.

5 Dry and Nearly Dry Wells Well Sampling

5.1 ***LOW FLOW SAMPLING***

The well will be considered purged and ready for sample collection once three of the indicator parameters have stabilized. Stabilization is indicated by at least three consecutive readings of three field parameters including pH, Specific Conductance, Turbidity, and Temperature as previously described in Section 4.2.2: *Primary Method - Low Flow Purging*, above. As a general policy, wells may be purged and sampled in the same day. Sample collection steps are as follows:

1. Collect groundwater samples as indicated in Section 5.3: *Sampling for Laboratory Analysis*.

2. Collect and record a final temperature measurement, to determine whether or not pumping activities have increased water temperature in the well.

3. After all sampling activities are completed at a well, disconnect and discard non-dedicated tubing along with other investigation derived waste in an appropriate manner.

5.2 ***DELAY OF SAMPLE COLLECTION***

Generally, wells are purged and sampled in the same day. However, many of the wells at the Lone Mountain Facility are low yield wells and are purged “dry” prior to the stabilization of the well using the low flow method as indicated in Section 4.2.2, or removal of three wells volumes if the bailer method is used as indicated in Section 4.2.3.

For these “dry” wells, as many samples as possible will be taken in the appropriate order, as defined in Section 5.3 *Sampling and Laboratory Analyses*, during the first visit to the well immediately after the stabilization or purging has been attempted. If there is not enough water in the well to complete the sampling, a twenty-four hour recharge period will be observed, after which a second and final attempt at sample collection will be conducted. After this twenty-four period, if the full set of required samples cannot be collected, the well will be considered "dry", and sampling of the well will end for that sampling event. The "dry" information will be entered into the field sampling logbook or the field data sheet and will also appear for those parameters not sampled in the final analytical narrative report for that well.

If after purging a well, inclement conditions such as rainfall, snow, freezing temperature, excessive wind, etc. cause a delay in sampling, the well may be sampled on the next day without further purging. If after collecting as many samples as possible, a complete set of samples cannot be collected on this (second) day, the well will be considered "dry", and no further attempts will be made to obtain a sample from the well during the event. The "dry" information will be entered into the field sampling logbook or the field data sheet and will also appear for those parameters not sampled in the final analytical narrative report for that well.

A site-specific schedule may be designed to maximize the number of wells which can be purged and/or sampled each day. The schedule will be made by the Technical Representative or his designee.

5.3 ***SAMPLING FOR LABORATORY ANALYSES***

Once the well is satisfactorily purged by low flow or bailer techniques, sample collection may begin.

1. Sample containers will usually come pre-labeled from the laboratory identifying the analyses and appropriate preservative. This is to assure proper bottle inventory during the gathering, sending, and receiving. If received without labels or correction are required, all bottles will be appropriately labeled at the facility and/or corrections will be made.
2. A team member will normally stage the sample containers necessary for the particular event in two groups. The lists below are based on total potential samples at this time. All analyses and parameters are not required for monitoring events. Additional analyses and parameters may be added to meet specific needs.

   Group I

   - Volatile Organic Compounds (Only BTEX analyzed in the Fall)

   Group II

   - Total Metals
   - Dissolved Metals
   - Semi-Volatile Organic Compounds
   - Pesticides and Herbicides
   - Gross Cations
   - Gross Anions
   - Alkalinity
   - Total Cyanide
   - Total Sulfide

   Group I analytes are flow-sensitive and will be collected first. The sequence of collection, other than Volatiles or BTEX, is not critical. Group II samples are not flow sensitive and the order of collection is not critical. However, the general order shown above will normally be followed.

Table 2: *Analytical Methods for Non-Metals* and Table 3: *Analytical Methods for Metals*, attached, present the current types[1], and suggested methods of analysis for each sample parameter from the most current SW-846 and/or 40 CFR Part 264. Acceptable reasons for changes to Tables 2 and 3 will include laboratory requirements, method-based requirements, etc. Changes of these types may be adopted immediately by CHESI with Tables 2 and 3 being updated and provided to the ODEQ in a timely manner. Additional parameters may also be included later, based on site-specific requirements. Practical Quantitation Limits (PQLs) for many compounds are listed in Appendix IX of 40 CFR Part 264, recognizing that these levels may not always be attainable due to a variety of factors, including matrix interference. Suggested methods are representative EPA procedures and may not always be the most suitable method(s) for monitoring an analyte. The footnotes to Appendix IX explain the PQLs and suggested methods more completely.

3. Sampling Group I analytes:

- The first sample to be taken will be for volatile organic analyses(VOA). It is common practice to sample VOAs at a minimal pump flow rate (<100 ml/min). In order to assure proper collection practices, the controller is adjusted to a rate which minimizes aeration and/or agitation as much as possible. Field experience has shown that mechanical circumstances sometimes cause serious difficulties in attaining the prescribed flow rate. However, when setting the flow rate the following procedure may be employed: Adjust the controller to deliver a small stream of water during the pump discharge cycle and observe the flow rate for possible

[1] The volumes listed in Tables 2 and 3 are the generally-accepted minimums. At times (e.g., slow recharge wells), the minimum volumes may not be available. In these cases, the Technical Representative may direct that a sample be collected if the Laboratory believes that a quality analytical result can be achieved.

changes during a few cycles. Using a stop watch, start timing the discharge cycle while capturing the water in a graduated cylinder. Each time the water stops running into the cylinder, stop the watch. Restart the stop watch when the flow begins again. Continue this process until 1 minute has expired on the stop watch. Observe the volume of water that has been caught in the cylinder. If the volume is >100 ml, readjust the controller and re-measure. Continue until the proper flow rate (<100 ml/min) has been set.

An alternative method is to first allow the pump to cycle until flow is established. Then, set the discharge timer to "infinity" and reduce the air pressure. Next, increase the air pressure slowly until water starts to flow. Collect the water in a graduated cylinder while timing for 1 minute. Continue until the proper flow rate (<100 ml/min) has been set. Other methods to determine the desired flow rate may also be employed.

Once the desired flow rate has been achieved, carefully add the water to the first <u>Volatile Organic</u> (VOA) vial. These vials have been pre-preserved with hydrochloric acid (pH <2). Make sure that one does not overfill the sample container, as sample flowing out of the container will result in dilution of the preservative. It is extremely important that there are no air bubbles in the sample after the cap has been placed on the vial. To check, place the cap on the vial, turn it upside down, and tap the vial against the hand to make sure there are no trapped air bubbles in the sample. If there is air in the sample, open the vial and add additional sample to displace the air. Recheck until there are no longer any trapped air bubbles. Fill the other VOA vials using the same technique. Place the vials in the cooler and continue with the next sample.

- In cases where the **only** VOA analysis required is for BTEX constituents (Benzene, Toluene, Ethylbenzene, and Xylene), the sample is collected with the same care, procedure, bottle, and analytical method as collecting VOA samples. Mark the chain of custody to indicate BTEX only if no other VOA analyte analysis is anticipated.

- Refer to Section 8 for instructions on collecting sample VOA samples with a bailer.

4. Sampling Group II analytes:

Once all of the necessary Group I analytes have been obtained, the flow rate may be increased to allow for more rapid sample collection. The general order for collecting Group II analytes is as follows:

- The sample for total metals will be taken next by filling the sample container to the neck. Containers for total metals will be pre-preserved with nitric acid to achieve a pH <2. Seal the container and place it in the cooler.

- The sample for semi-volatile organic compounds (SVOCs) will be taken in a one liter bottle, by filling to the neck, capping, and placing in the cooler. There may be times when an additional one gallon bottle is filled for pesticides. This sample will be collected at this point, filled as above, capped, and placed in the cooler. No preservatives are used for either of these samples.

- The container for anions and alkalinity not requiring a preservative is filled to the shoulder, capped, and placed in the cooler.

- The sample for total cyanide is filled to the neck of the container that is pre-preserved with sodium hydroxide (NaOH) at a pH of >12. Cap the bottle and return it to the cooler.

- The sample for total sulfide is filled to the neck of the container that is pre-preserved with zinc acetate. Cap the bottle and return it to cooler.

5.4 ***ENDING INDIVIDUAL WELL SAMPLING***

When the final sample has been taken at the well site, the following procedure is used to secure the site and prepare the team to move to the next sampling location:

- Remove the pump controller hose from the well pump.
- Secure the well by replacing the cap and putting the lock in place. Make sure any protective covers or caps have been put in place and secured.
- Repack the vehicle, so that the analytical instrumentation and pump controller are readily accessible for the next well sampling.
- Pick up the ground cloth and dispose of properly.
- Secure all excess groundwater and rinses in a waste container for disposal.
- Dispose of gloves and any other PPE used at the well site.
- Proceed to the next sampling site on the established circuit.

5.5 ***ENDING THE SAMPLING EVENT***

After the final sample has been collected for a given sampling day, the following protocol is used to complete the documentation and send the samples to the laboratory for analyses:

- After returning to the staging area, a team member will check each cooler to make sure that all planned samples have been collected and are packed securely. Packaged ice, "blue ice", or other ice preservative is acceptable as a coolant. Coolers filled during the day may be left in a secure (locked) area.
- A team member will verify the transfer of all field analytical data to field data sheets.
- At least one person will review the chain-of-custody forms and make sure they are placed in the courier pouch. The cooler is banded and sealed with chain-of-custody tape. Copies of the chain-of-custody forms may also be sent via facsimile to the laboratory.
- The bill of lading and documentation will be prepared to send the samples to the laboratory using an overnight delivery service, in a time frame to assure that the samples will arrive at the laboratory the next day. As an option, the samples may be escorted, sent by courier, or delivered by CHESI personnel.
- A team member removes the field analytical instrumentation, calibration standards, and other standards from the sampling vehicle and stores in the appropriate place if sampling activities will not resume within the next 7 days. If temperatures are expected to be cold, these items will be removed from vehicles and stored in a building overnight.
- All team members will be responsible for removal and storage of personal safety equipment used during the sampling event, if necessary.
- The Technical Representative or designee will review the documentation package generated during the sampling day, making sure it is complete. The responsible person will complete any necessary information or documentation.
- A team member will remove all additional equipment from the sampling vehicle and place it in the appropriate storage area if sampling activities will not resume within the next 7 days.

- At the conclusion of the entire sampling event, the Technical Representative will be responsible for assuring that a commentary is written (which will be included in the final report) which describes the sampling event, including any problems with or variations from the SOP that may have occurred.

6 Documentation and Document Control

Management of the documentation package is a critical aspect of the sampling, as it provides assurance that all requirements of the facility groundwater sampling and analysis procedure are being followed, as well as providing a complete record of activities prior to and during the event. Documentation must be processed completely and accurately.

7 Total Depth Readings (Annual or As Required)

Total depth readings for each well are measured electronically using a an Interface Probe. This procedure will not be performed during the actual sampling event. Total depth readings are normally taken the week prior to the start of the sampling event as per the following order of activities:

1. After arrival at the first well on the schedule, a team member logs the date, time, *ambient temperature, *wind direction, *wind speed, *barometric pressure (*recorded at least once per day from facility information), and individuals present at the event (including team members and any observers). This information will be recorded on a field data sheet, log book, or similar document.

2. A team member notes the condition of the well, including whether or not the lock was in place, any evidence of

tampering, if there is any water standing at or near the well, and the condition of the apron. This information will be recorded on a field data sheet, logbook, or similar document.

3. The designated team member will proceed as follows:

a. After unlocking and opening the protective casing cover, the well is checked for organic vapors using the OVM as outlined above. In the absence of any organic vapors, proceed. If organic vapors greater than 2 ppm are measured in the breathing zone, follow procedures as found in Section 2.2.2: *Health and Safety*. Grasping the PVC well cap with both hands, gently remove the cap and lift upwards. Since the pump and tubing are attached to the cap, the pump will be removed as the cap is raised. Carefully coil the tubing and place the cap, coiled tubing, and pump into a large, clean, plastic, disposable bag. Close and seal the bag containing the pump and tubing. Care must be taken to avoid letting the cap, tubing, or pump touch anything other than the inside of the bag.

c. Slowly lower the "Interface Probe" into the well until it gently touches the bottom of the well. Record the depth when tension in the cable is relieved as the probe touches the bottom of the well. Raise the probe above the bottom and then lower it again to the bottom to take a second reading. If both the readings are the same, record the value; if not, take additional readings until at least two readings are the same and record the value. The readings are taken/recorded to the nearest 0.01 ft. as measured from the top of the well casing and adjusted to account for the thickness of the PVC well cap and for any additional discrepancy caused by the specific position of the measuring device. The base datum is the top of the PVC well cap.

d. An advantage to the use of the "Interface Probe" is its ability to measure immiscibles, both dense and light phase. The cable is calibrated, and the probe will emit a signal when lowered slowly in the casing if a Light Non-Aqueous Phase Liquid (LNAPL) is encountered. A different signal is obtained when water is reached. This second signal is continuous to the bottom unless a Dense Non-Aqueous Phase Liquid (DNAPL) is encountered, which will cause the first signal to reoccur. Thus, the thickness of any non-aqueous phase can be determined. Other checks for potential immiscibles are made by analyses of the groundwater samples that are collected during the sampling event.

4. Slowly remove the probe from the well, being careful to wipe both cable and probe with a Kimwipe® (or other disposal material) moistened with deionized/distilled water as it is removed. Care must be taken to avoid letting the cable and probe touch the ground. If a LNAPL or DNAPL were encountered, the decontamination procedure would include a detergent wash and rinse followed by a deionized/distilled water rinse. An acetone/hexane rinse is not recommended except in extreme circumstances. In the event normal cleaning procedures are not effective, an acetone/hexane rinse will precede the detergent and deionized/distilled water wash/rinse. These procedures may be performed in the field or upon returning to the laboratory or other field facility.

5. If LNAPLs/DNAPLs are detected, the facility Technical Representative will be notified. Arrangements will be made to sample the well to investigate the presence of potential contamination prior to notification of regulatory personnel (ODEQ).

6. Minor maintenance of the pump may be undertaken while the assembly is accessible on the surface. Extensive maintenance will require scheduling.

7. Remove the pump, tubing, and cap from the plastic bag and rinse both the pump and the first few feet of tubing with deionized/distilled water. After rinsing, insert the pump and first few feet of tubing back into the well. Prior to reinserting the remaining tubing and well cap, they too should be rinsed with deionized/distilled water or thoroughly wiped with a Kimwipe® (or other disposable material) moistened with deionized/distilled water. Gently lower the pump and tubing back into the well; abrupt actions could separate the components.

8. Securely push the cap back onto the well casing, making sure that the cap is flush with the top of the casing.

9. Secure the protective casing cover and proceed to the next well in the circuit.

8 Observation Wells or Malfunctioning Monitoring Wells

Observation wells may be included in the monitoring of groundwater, although these wells are not constructed as monitoring wells and do not have dedicated pumps. These wells may be managed and monitored as per the established methods and procedures found elsewhere in this document. Conversely, wells with dedicated pumps may sometimes need to be sampled with a bailer. Procedures are as follows:

- Samples will be collected through the use of a disposable bailer. The bailer, if left in the well between sampling events, does not have to be disposed after each use.

- Purging and sampling will be conducted by carefully lowering the bailer down the well until it is fully immersed in fluid and then returning it to the surface. Discard the water into a waste container, if it is being purged, or into the appropriate sample container, if the well is ready to be sampled.

- Samples for VOC analyses will be collected first. To minimize the effect of aeration on the water sample, a disposable flow-reducing tip will be attached to the end of the bailer before the VOC samples are collected. This tip greatly reduces the water flow rate by allowing the sample to trickle out of the tip, thus minimizing aeration. After each VOC vial is filled, the vial will be inverted and checked for air bubbles to ensure zero headspace. If a bubble appears, the vial will be discarded and a new sample will be collected.

- During purging and sampling it is extremely important to avoid touching the bailer or the associated sampling cord on the ground or any potentially-contaminated surface.

- Disposable bailers will be stored in the original sealed plastic bag prior to initial use.

9 Pump Management Standards

Periodically, it may be necessary take pumps out of the system for repair or replacement. Dedicated pumps may be placed in a different well only if certified to be clean and operational. A dedicated pump removed for maintenance may later be placed back in the same well after thorough decontamination without the certification described below The following procedures will be useful to remove the pump and certify that it is clean and fully operational.

9.1 ***PUMP REMOVAL AND SHIPPING***

Pumps will be removed from the well casing as per the instructions found in Section 7: *Total Depth Readings*.

- After the pump and tubing have been removed, both will be placed in a plastic bag for transport to the cleaning area or off-site maintenance location.

9.2 ***PUMP CLEANING***

The pump will be disassembled according to the manufacturer's instructions. The repair person will use protective gloves.

- After disassembly, all parts coming in contact with groundwater will be washed according to the following protocol:
    1. Wash with a strong laboratory soap such as Alconox®.
    2. Rinse with tap water.
    3. Triple rinse with deionized/distilled water.

9.3 ***PUMP REASSEMBLY***

While the pump and parts are still wet (if applicable), the pump should be carefully reassembled. Clean vinyl gloves should be worn from this point forward whenever the pump is being handled.

- Any parts that appear to be excessively worn should be replaced with original manufacturer's parts.
- Tubing will be cleaned according to the procedures above for the pump or discarded.

9.4 ***PUMP CERTIFICATION***

The pump will be certified to perform according to the original manufacturer's specifications by first placing the pump in a container of deionized/distilled water and starting the pump controller. The pump should meet or exceed the volume flow specification as per the manufacturer. If the pump does not pass, it is likely that parts need to be replaced. The testing will be repeated until the flow requirements are met.

- When the operational criteria have been met, the pump will be certified to be contamination-free by allowing deionized/distilled water to flow through the tubing and pumping mechanism. After the water has passed through the pump, a sample will be collected for analysis of volatiles. Certification will occur if all volatile compounds in the sample are equal to or less than the detection limit. If any analytes are detected above the detection limit, the pump will be disassembled and the cleaning process will be repeated.

- Tubing - To be reused, tubing must also be certified as above.

- Packaging - Following the sampling for certification, the pump (and tubing) will be carefully wrapped in clean aluminum foil. Extreme care should be taken in wrapping the tubing and pump parts so that surface exposure is minimized. After wrapping in aluminum foil, the pump should be placed in a clean plastic bag.

- Installation - Upon completion of the certification steps above, the pump can be installed in the well casing following the manufacturer's recommendations and methods in Section 7: *Total Depth Readings*. A minimum of ten liters of well water should be flushed through the pump before any samples for analysis are taken.

TABLE 1

TYPICAL EXAMPLE

Routing for Purging and Sampling

Clean Harbors Lone Mountain, LLC

Monitoirng Well	Group	Monitoirng Well	Group
MW 1A	1	MW 15A11	3
MW 1B	1	MW 15A13A	3
MW 2A1	1	MW 15A13B	3
MW 2B	1	MW 15A13C	3
MW 3A	1	RFI-2A	3
MW 8A1	1	RFI-4A	3
MW 8A2	1	RFI-5	3
MW 8A3	1	RFI-6	3
MW 13A1	1	RFI-7	3
MW 13A2	1	RFI-9	3
MW 14A1	1	RFI-11	3
MW 14B1	1	RFI-15	3
MW 14A2	1	RFI-16	3
MW 14B2	1	RFI-17	3
MW-21	1	MW 4A1	4
MW-22	1	MW 4A2	4
MW 11A2	2	MW 4A3(New)	4
MW 11A4	2	MW 5A1	4
MW 11A5	2	MW 5A2	4
MW 12A1	2	MW 5A3	4
MW 12B1	2	MW 6A1	4
MW 12B2	2	MW 6A2	4
MW 15A1	2	CM-9	4
MW 15A2	2	CM-10	4
MW 15A3	2	RFI-1	4
MW 15A4	2	RFI-3A	4
MW 15A5	2	RFI-10	4
MW 15A6	2	RFI-14	4
MW 15A7	2		
MW 15A8	2		
MW 15A10	2		

NOTE: Route is based on purging/sampling "clean" wells first, followed by wells with known or possible contaminants. Within the clean" or "contaminated" Groups, the order may change based on the project leader's discretion. All wells may not be purged/sampled on the day scheduled.

Table 2
Analytical Methods for Non-Metals
Clean Harbors Lone Mountain, LLC

Alkalinity, Total	Water	SM 2320B-2011	100 ml	14 days	P or G
Chloride, IC	Water	EPA 300.0	25 ml	28 days	P or G
Conductivity	Water	EPA/SW 9050	100 ml	28 days	P or G
pH	Water	SM 4500H+B-2011	25 ml	24 hours	P or G
Sulfate	Water	EPA 300.0	25 ml	28 days	P or G
Pesticides	Water	EPA/SW 8081B	1 liter	40 days (1)	G only
Semi-Volatile Organic Analysis	Water	SW846 8270D	1 liter	40 days(1)	G only
Volatile Organic Analysis	Water	SW846 8260C	3 X 40 ml	14 days	G septa vial

Notes:

1. Extractions must be performed within seven (7) days of sampling.

2. P = Plastic, G = Glass

3. More than one parameter could be analyzed from a single sample if the container type and preservation method are identical. Volumes suggested are for single parameters only.

Table 3
Analytical Methods for Metals
Clean Harbors Lone Mountain, LLC

Parameters	Matrix	Suggested Methods	Volume(1)	Holding Time	Container
Arsenic	Water	EPA/SW 6010C	500 ml	6 months	P only
Barium	Water	EPA/SW 6010C	500 ml	6 months	P only
Beryllium	Water	EPA/SW 6010C	500 ml	6 months	P only
Cadmium	Water	EPA/SW 6010C	500 ml	6 months	P only
Calcium	Water	EPA/SW 6010C	500 ml	6 months	P only
Chromium	Water	EPA/SW 6010C	500 ml	6 months	P only
Lead	Water	EPA/SW 6010C	500 ml	6 months	P only
Magnesium	Water	EPA/SW 6010C	500 ml	6 months	P only
Mercury	Water	EPA/SW 7470A	500 ml	28 days	P only
Selenium	Water	EPA/SW 6010C	500 ml	6 months	P only
Sodium	Water	EPA/SW 6010C	500 ml	6 months	P only

Notes:

1 All metals analysis can be performed on a single 500 ml aliquot.

Table 4
Operating and Post-Closure Groundwater Monitoring Wells
Clean Harbors Lone Mountain, LLC

Upgradient Wells (5)
MW 1A
MW 1B
MW 2A1
MW 2B
MW 3A
Downgradient Point-of-Compliance Wells (8)
MW 15A6
MW 15A7
MW 15A8
MW 15A10
MW 15A11
MW 15A13A
MW 15A13B
MW 15A13C
Downgradient Post-Closure Point-of-Compliance Monitoring Wells (14)
MW 4A1
MW 4A2
MW 8A1
MW 8A2
MW 8A3
MW 11A2
MW 11A4
MW 12A1
MW 12B1
MW 15A1
MW 15A2
MW 15A3
MW 15A4
MW 15A5
Downgradient Post-Closure Detection Monitoring Wells (15)
CM-9
CM-10
MW 4A3(new)
MW 6A1
MW 6A2
MW-21
MW-22
MW 11A5
MW 12B2
MW 14A2
MW 14B2
MW 13A1
MW 13A2
MW 14A1
MW 14B1

Table 5
Corrective Action Groundwater Monitoring Wells
Clean Harbors Lone Mountain, LLC

Corrective Action Point of Compliance Wells (9)	
Cell 5 Corrective Action Point of Compliance Well	RFI-1
Cell 5 Corrective Action Point of Compliance Well	RFI-2A
Cell 5 Corrective Action Point of Compliance Well	RFI-3A
Cell 5 Corrective Action Point of Compliance Well	RFI-4A
Cell 5 Corrective Action Point of Compliance Well	RFI-5
Cell 5 Corrective Action Point of Compliance Well	RFI-6
Cell 5 Corrective Action Point of Compliance Well	RFI-7
Cell 5 Corrective Action Point of Compliance Well	RFI-9
Cell 5 Deep Corrective Action Point of Compliance Well	RFI-17
Corrective Action Source Zone Monitoring Wells (8)	
Cell 5 Primary Recovery Corrective Action Source Zone Monitoring Well	RFI-14
Cell 5 Corrective Action Source Zone Monitoring Well	MW 5A1
Cell 5 Corrective Action Source Zone Monitoring Well	MW 5A2
Cell 5 Corrective Action Source Zone Monitoring Well	MW 5A3
Cell 5 Corrective Action Source Zone Monitoring Well	RFI-10
Cell 5 Corrective Action Source Zone Monitoring Well	RFI-11
Cell 5 Corrective Action Source Zone Monitoring Well	RFI-15
Cell 5 Deep Corrective Action Source Zone Monitoring Well	RFI-16

Table 6
Semi-Annual Inorganic Parameter Monitoring List
(Spring and Fall)
Clean Harbors Lone Mountain, LLC

Parameter	Type	CAS Number
ALKALINITY, BICARBONATE	GC	
ALKALINITY, CARBONATE	GC	
ARSENIC (TOTAL)	RCRA	7440-38-2
BARIUM (TOTAL)	RCRA	7440-39-3
BERYLLIUM (TOTAL)	RCRA	7440-41-7
CADMIUM (TOTAL)	RCRA	7440-43-9
CALCIUM (TOTAL)	GC	7440-70-2
CHLORIDE	GA	
CHROMIUM (TOTAL)	RCRA	7440-47-3
LEAD (TOTAL)	RCRA	7439-92-1
MAGNESIUM (TOTAL)	GC	7439-95-4
MERCURY (TOTAL)	RCRA	7439-97-6
PH, FIELD	Field	
SELENIUM (TOTAL)	RCRA	7782-49-2
SODIUM (TOTAL)	GC	7440-23-5
SPECIFIC CONDUCTANCE, FIELD	Field	
SULFATE	GA	14808-79-8
TEMPERATURE, FIELD	Field	

Table 7
Spring List of Organic Constituents
Clean Harbors Lone Mountain, LLC

Parameter	CAS Number	Parameter	CAS Number
Semi-Volatile		Volatile	
1,2,4,5-TETRACHLOROBENZENE	95-94-3	1,1,1,2-TETRACHLOROETHANE	630-20-6
1,2,4-TRICHLOROBENZENE	120-82-1	1,1,1-TRICHLOROETHANE	71-55-6
1,3,5-TRINITROBENZENE	99-35-4	1,1,2,2-TETRACHLOROETHANE	79-34-5
1-NAPHTHYLAMINE	134-32-7	1,1,2-TRICHLOROETHANE	79-00-5
2,3,4,6-TETRACHLOROPHENOL	58-90-2	1,1-DICHLOROETHANE	75-34-3
2,4,5-TRICHLOROPHENOL	95-95-4	1,2,3-TRICHLOROPROPANE	96-18-4
2,4,6-TRICHLOROPHENOL	88-06-2	1,2-DICHLOROETHANE	107-06-2
2,4-DICHLOROPHENOL	120-83-2	1,2-DICHLOROPROPANE	78-87-5
2,4-DIMETHYLPHENOL	105-67-9	1,4-DIOXANE	123-91-1
2,4-DINITROPHENOL	51-28-5	2-HEXANONE	591-78-6
2,4-DINITROTOLUENE	121-14-2	3-CHLOROPROPENE (ALLYL CHLORI	107-05-1
2,6-DICHLOROPHENOL	87-65-0	4-METHYL-2-PENTANONE (MIBK)	108-10-1
2,6-DINITROTOLUENE	606-20-2	ACETONITRILE	75-05-8
2-CHLORONAPHTHALENE	91-58-7	BENZENE	71-43-2
2-CHLOROPHENOL	95-57-8	BROMODICHLOROMETHANE	75-27-4
2-METHYLNAPHTHALENE	91-57-6	BROMOFORM	75-25-2
2-NAPHTHYLAMINE	91-59-8	BROMOMETHANE	74-83-9
3,3-DICHLOROBENZIDINE	91-94-1	CARBON DISULFIDE	75-15-0
3-METHYLCHOLANTHRENE	56-49-5	CARBON TETRACHLORIDE	56-23-5
4,4'-DDD	72-54-8	CHLOROBENZENE	108-90-7
4,4'-DDE	72-55-9	CHLOROETHANE	75-00-3
4,4'-DDT	50-29-3	CHLOROFORM	67-66-3
4-AMINOBIPHENYL	92-67-1	CHLOROMETHANE	74-87-3
4-BROMOPHENYL PHENYL ETHER	101-55-3	CIS-1,2-DICHLOROETHENE (DCE)	156-59-2
4-CHLOROPHENYL PHENYL ETHER	7005-72-3	CIS-1,3-DICHLOROPROPENE	10061-01-5
4-NITROQUINOLINE-1-OXIDE	56-57-5	DIBROMOCHLOROMETHANE	124-48-1
ACENAPHTHENE	83-32-9	DIBROMOMETHANE	74-95-3
ACENAPHTHYLENE	208-96-8	DICHLORODIFLUOROMETHANE	75-71-8
ACETOPHENONE	98-86-2	ETHYL METHACRYLATE	97-63-2
ALDRIN	309-00-2	ETHYLBENZENE	100-41-4
ALPHA-BHC	319-84-6	IODOMETHANE	74-88-4
ANTHRACENE	120-12-7	ISOBUTYL ALCOHOL	78-83-1
ARAMITE	140-57-8	METHYL METHACRYLATE	80-62-6
BENZO(A)ANTHRACENE	56-55-3	METHYLENE CHLORIDE	75-09-2
BENZO(A)PYRENE	50-32-8	PROPIONITRILE	107-12-0
BENZO(B)FLUORANTHENE	205-99-2	STYRENE	100-42-5
BENZO(G,H,I)PERYLENE	191-24-2	TETRACHLOROETHENE	127-18-4
BENZO(K)FLUORANTHENE	207-08-9	TOLUENE	108-88-3
BENZYL ALCOHOL	100-51-6	TOTAL XYLENES	1330-20-7
BETA-BHC	319-85-7	TRANS-1,2-DICHLOROETHENE	156-60-5
BIS(2-ETHYLHEXYL) PHTHALATE	117-81-7	TRANS-1,3-DICHLOROPROPENE	10061-02-6
BUTYL BENZYL PHTHALATE	85-68-7	TRANS-1,4-DICHLORO-2-BUTENE	110-57-6
CHLORDANE	57-74-9	TRICHLOROETHENE	79-01-6

Table 7

Spring List of Organic Constituents

Clean Harbors Lone Mountain, LLC

Parameter	CAS Number	Parameter	CAS Number
Semi-Volatile		Volatile	
CHLOROBENZILATE	510-15-6	TRICHLOROFLUOROMETHANE	75-69-4
CHRYSENE	218-01-9	VINYL ACETATE	108-05-4
DELTA-BHC	319-86-8	VINYL CHLORIDE	75-01-4
DIALLATE	2303-16-4		
DIBENZ(A,H)ANTHRACENE	53-70-3		
DIBENZOFURAN	132-64-9		
DIELDRIN	60-57-1		
DIETHYL PHTHALATE	84-66-2		
DIMETHYL PHTHALATE	131-11-3		
DI-N-BUTYL PHTHALATE	84-74-2		
DI-N-OCTYL PHTHALATE	117-84-0		
ENDOSULFAN I	959-98-8		
ENDOSULFAN II	33213-65-9		
ENDOSULFAN SULFATE	1031-07-8		
ENDRIN	72-20-8		
ENDRIN ALDEHYDE	7421-93-4		
ETHYL METHANESULFONATE	62-50-0		
FLUORANTHENE	206-44-0		
GAMMA-BHC (LINDANE)	58-89-9		
HEPTACHLOR	76-44-8		
HEPTACHLOR EPOXIDE	1024-57-3		
HEXACHLOROBENZENE	118-74-1		
HEXACHLOROCYCLOPENTADIENE	77-47-4		
HEXACHLOROETHANE	67-72-1		
HEXACHLOROPHENE	70-34-4		
HEXACHLOROPROPENE	1888-71-7		
INDENO(1,2,3-C,D)PYRENE	193-39-5		
ISODRIN	465-73-6		
ISOPHORONE	78-59-1		
KEPONE	143-50-0		
METHOXYCHLOR	72-43-5		
NAPHTHALENE	91-20-3		
NITROBENZENE	98-95-3		
O-TOLUIDINE	95-53-4		
PENTACHLOROBENZENE	608-93-5		
PENTACHLORONITROBENZENE	82-68-8		
PENTACHLOROPHENOL	87-86-5		
PHENANTHRENE	85-01-8		
PHENOL	108-95-2		
P-PHENYLENEDIAMINE	106-50-3		
PRONAMIDE	23950-58-5		
PYRENE	129-00-0		
TOXAPHENE	8001-35-2		

Table 8
Fall List of Organic Constituents
Clean Harbors Lone Mountain, LLC

Parameter	Type	CAS Number
BTEX		
Benzene	Volatile	71-43-2
Toluene	Volatile	108-88-3
Ethylbenzene	Volatile	100-41-4
Xylene (Total)	Volatile	1331-20-7

Table 9
Corrective Action List of Constituents
(Spring and Fall)
Clean Harbors Lone Mountain, LLC

Parameter	Type	CAS Number
Tetrachloroethene (Perchloroethylene or PCE)	Volatile	127-18-4
Trichloroethene (Trichloroethylene or TCE)	Volatile	79-01-6
Cis-1,2-Dichloroethene (DCE)	Volatile	156-59-2
Vinyl Chloride (VC)	Volatile	75-01-4

Table 10
Constituent Detection Limits
Clean Harbors Lone Mountain, LLC

Parameter Name	MDL	Units	Method	CAS No.
1,1,1,2-Tetrachloroethane	0.46	ug/l	SW8260C	630-20-6
1,1,1-Trichloroethane	0.33	ug/l	SW8260C	71-55-6
1,1,2,2-Tetrachloroethane	0.46	ug/l	SW8260C	79-34-5
1,1,2-Trichloroethane	0.47	ug/l	SW8260C	79-00-5
1,1-Dichloroethane	0.43	ug/l	SW8260C	75-34-3
1,2,3-Trichloropropane	0.45	ug/l	SW8260C	96-18-4
1,2,4,5-Tetrachlorobenzene	0.5	ug/l	SW8270D	95-94-3
1,2,4-Trichlorobenzene	1.1	ug/l	SW8270D	120-82-1
1,2-Dichloroethane	0.4	ug/l	SW8260C	107-06-2
1,2-Dichloropropane	0.38	ug/l	SW8260C	78-87-5
1,3,5-Trinitrobenzene	0.99	ug/l	SW8270D	99-35-4
1,4-Dioxane	25	ug/l	SW8260C	123-91-1
1-Naphthylamine	1.2	ug/l	SW8270D	134-32-7
2,3,4,6-Tetrachlorophenol	0.97	ug/l	SW8270D	58-90-2
2,4,5-Trichlorophenol	0.74	ug/l	SW8270D	95-95-4
2,4,6-Trichlorophenol	0.75	ug/l	SW8270D	88-06-2
2,4-Dichlorophenol	0.84	ug/l	SW8270D	120-83-2
2,4-Dimethylphenol	0.74	ug/l	SW8270D	105-67-9
2,4-Dinitrophenol	5	ug/l	SW8270D	51-28-5
2,4-Dinitrotoluene	0.81	ug/l	SW8270D	121-14-2
2,6-Dichlorophenol	0.83	ug/l	SW8270D	87-65-0
2,6-Dinitrotoluene	0.71	ug/l	SW8270D	606-20-2
2-Chloronaphthalene	0.5	ug/l	SW8270D	91-58-7
2-Chlorophenol	0.63	ug/l	SW8270D	95-57-8
2-Hexanone	3.2	ug/l	SW8260C	591-78-6
2-Methylnaphthalene	0.6	ug/l	SW8270D	91-57-6
2-Methylphenol	0.56	ug/l	SW8270D	95-48-7
2-Naphthylamine	1.2	ug/l	SW8270D	91-59-8
3,3'-Dichlorobenzidine	0.64	ug/l	SW8270D	91-94-1
3-Chloro-1-Propene (Allyl Chloride)	0.49	ug/l	SW8260C	107-05-1
3-Methylcholanthrene	1	ug/l	SW8270D	56-49-5
4,4'-DDD	1	ug/l	SW8081B	72-54-8
4,4'-Dde	1	ug/l	SW8081B	72-55-9
4,4'-DDT	1	ug/l	SW8081B	50-29-3
4-Aminobiphenyl	0.8	ug/l	SW8270D	92-67-1
4-Bromophenyl Phenyl Ether	0.85	ug/l	SW8270D	101-55-3
4-Chlorophenyl Phenyl Ether	0.54	ug/l	SW8270D	7005-72-3
4-Methyl-2-Pentanone	2.9	ug/l	SW8260C	108-10-1
4-Nitroquinoline-1-Oxide	5	ug/l	SW8270D	56-57-5
Acenaphthene	0.63	ug/l	SW8270D	83-32-9
Acenaphthylene	0.64	ug/l	SW8270D	208-96-8
Acetonitrile	3.1	ug/l	SW8260C	75-05-8
Acetophenone	0.81	ug/l	SW8270D	98-86-2
Aldrin	0.54	ug/l	SW8081B	309-00-2
Alkalinity (Total)	2	mg/l	SM2320-B	Not Applicable
Alkalinity as CaCO3	2	mg/l	SM2320-B	Not Applicable
Alpha-Bhc	0.44	ug/l	SW8081B	319-84-6
Alpha-Endosulfan	0.32	ug/l	SW8081B	959-98-8
Anthracene	0.8	ug/l	SW8270D	120-12-7
Aramite	2	ug/l	SW8270D	140-57-8
Arsenic (Total)	0.004	mg/l	SW6010C	7440-38-2
Barium (Total)	0.004	mg/l	SW6010C	7440-39-3
Benzene	0.4	ug/l	SW8260C	71-43-2
Benzo(A)Anthracene	0.76	ug/l	SW8270D	56-55-3
Benzo(A)Pyrene	0.78	ug/l	SW8270D	50-32-8
Benzo(B)Fluoranthene	0.78	ug/l	SW8270D	205-99-2
Benzo(G,H,I)Perylene	0.82	ug/l	SW8270D	191-24-2
Benzo(K)Fluoranthene	0.86	ug/l	SW8270D	207-08-9
Benzyl Alcohol	0.61	ug/l	SW8270D	100-51-6
Benzyl Butyl Phthalate	1	ug/l	SW8270D	85-68-7
Beryllium (Total)	0.001	mg/l	SW6010C	7440-41-7

Table 10
Constituent Detection Limits
Clean Harbors Lone Mountain, LLC

Parameter Name	MDL	Units	Method	CAS No.
Beta-Bhc	0.51	ug/l	SW8081B	319-85-7
Beta-Endosulfan	0.3	ug/l	SW8081B	33213-65-9
Bis(2-Ethylhexyl) Phthalate	1	ug/l	SW8270D	117-81-7
Bromodichloromethane	0.39	ug/l	SW8260C	75-27-4
Bromoform	0.36	ug/l	SW8260C	75-25-2
Bromomethane	0.3	ug/l	SW8260C	74-83-9
Cadmium (Total)	0.001	mg/l	SW6010C	7440-43-9
Calcium (Total)	0.092	mg/l	SW6010C	7440-70-2
Carbon Disulfide	1.01	ug/l	SW8260C	75-15-0
Carbon Tetrachloride	0.35	ug/l	SW8260C	56-23-5
Chlordane (Technical)	7.5	ug/l	SW8081B	12789-03-6
Chloride (Total)	0.7	mg/l	E300.0A	16887-00-6
Chlorobenzene	0.39	ug/l	SW8260C	108-90-7
Chloroethane	0.35	ug/l	SW8260C	75-00-3
Chloroform	0.39	ug/l	SW8260C	67-66-3
Chloromethane	0.42	ug/l	SW8260C	74-87-3
Chromium (Total)	0.002	mg/l	SW6010C	7440-47-3
Chrysene	0.85	ug/l	SW8270D	218-01-9
Cis-1,2-Dichloroethene	0.42	ug/l	SW8260C	156-59-2
Cis-1,3-Dichloropropene	0.39	ug/l	SW8260C	10061-01-5
Delta-Bhc	0.48	ug/l	SW8081B	319-86-8
Diallate	1	ug/l	SW8270D	2303-16-4
Dibenzo(A,H)Anthracene	0.8	ug/l	SW8270D	53-70-3
Dibenzofuran	0.6	ug/l	SW8270D	132-64-9
Dibromochloromethane	0.46	ug/l	SW8260C	124-48-1
DIBROMOMETHANE	0.39	ug/l	SW8260C	74-95-3
Dibromochloropropane (DBCP)	0.39	ug/l	SW8260C	96-12-8
Dichlorodifluoromethane	0.67	ug/l	SW8260C	75-71-8
Dieldrin	0.47	ug/l	SW8081B	60-57-1
Diethyl Phthalate	1	ug/l	SW8270D	84-66-2
Dimethyl Phthalate	1	ug/l	SW8270D	131-11-3
Di-n-Butyl Phthalate	1	ug/l	SW8270D	84-74-2
Di-n-Octyl Phthalate	1	ug/l	SW8270D	117-84-0
Endosulfan Sulfate	0.32	ug/l	SW8081B	1031-07-8
Endrin	0.42	ug/l	SW8081B	72-20-8
Endrin Aldehyde	0.55	ug/l	SW8081B	7421-93-4
Ethyl Methacrylate	0.48	ug/l	SW8260C	97-63-2
Ethyl Methanesulfonate	1.1	ug/l	SW8270D	62-50-0
Ethylbenzene	0.41	ug/l	SW8260C	100-41-4
Fluoranthene	0.55	ug/l	SW8270D	206-44-0
Gamma-Bhc (Lindane)	0.44	ug/l	SW8081B	58-89-9
Heptachlor	0.52	ug/l	SW8081B	76-44-8
Heptachlor Epoxide	0.41	ug/l	SW8081B	1024-57-3
Hexachloro-1,3-Cyclopentadiene	1.8	ug/l	SW8270D	77-47-4
Hexachlorobenzene	0.69	ug/l	SW8270D	118-74-1
Hexachloroethane	1.6	ug/l	SW8270D	67-72-1
Hexachlorophene	50	ug/l	SW8270D	70-30-4
Hexachloropropene	2	ug/l	SW8270D	1888-71-7
Indeno(1,2,3-C,D)Pyrene	0.71	ug/l	SW8270D	193-39-5
Iodomethane	0.4	ug/l	SW8260C	74-88-4
Isobutanol	20	ug/l	SW8260C	78-83-1
Isodrin	1	ug/l	SW8270D	465-73-6
Isophorone	0.78	ug/l	SW8270D	78-59-1
Kepone	4	ug/l	SW8270D	143-50-0
Lead (Total)	0.003	mg/l	SW6010C	7439-92-1
Magnesium (Total)	0.09	mg/l	SW6010C	7439-95-4
Mercury (Total)	0.00008	mg/l	SW7470A	7439-97-6
Methoxychlor	1	ug/l	SW8081B	72-43-5
Methyl Methacrylate	0.44	ug/l	SW8260C	80-62-6
Methylene Chloride	1.6	ug/l	SW8260C	75-09-2
Naphthalene	0.5	ug/l	SW8270D	91-20-3

Table 10
Constituent Detection Limits
Clean Harbors Lone Mountain, LLC

Parameter Name	MDL	Units	Method	CAS No.
Nitrobenzene	0.93	ug/l	SW8270D	98-95-3
O,O-Diethyl-O-2-Pyrazinyl Phosphorothioate	1.2	ug/l	SW8270D	95-53-4
P-Chlorobenzilate	1.1	ug/l	SW8270D	510-15-6
Pentachlorobenzene	3.1	ug/l	SW8270D	608-93-5
Pentachloronitrobenzene	1.6	ug/l	SW8270D	82-68-8
Pentachlorophenol	5	ug/l	SW8270D	87-86-5
Phenanthrene	0.86	ug/l	SW8270D	85-01-8
Phenol	0.5	ug/l	SW8270D	108-95-2
P-Phenylene Diamine	10	ug/l	SW8270D	106-50-3
Pronamide	1.3	ug/l	SW8270D	23950-58-5
Propionitrile	8.2	ug/l	SW8260C	107-12-0
Pyrene	0.68	ug/l	SW8270D	129-00-0
Selenium (Total)	0.005	mg/l	SW6010C	7782-49-2
Sodium (Total)	0.17	mg/l	SW6010C	7440-23-5
Styrene	0.4	ug/l	SW8260C	100-42-5
Sulfate	0.5	mg/l	E300.0A	14808-79-8
Tetrachloroethene	0.37	ug/l	SW8260C	127-18-4
Toluene	0.42	ug/l	SW8260C	108-88-3
Toxaphene	43	ug/l	SW8081B	8001-35-2
Trans-1,2-Dichloroethene	0.42	ug/l	SW8260C	156-60-5
Trans-1,3-Dichloropropene	0.37	ug/l	SW8260C	10061-02-6
Trans-1,4-Dichloro-2-Butene	0.42	ug/l	SW8260C	110-57-6
Trichloroethene	0.41	ug/l	SW8260C	79-01-6
Trichlorofluoromethane	0.36	ug/l	SW8260C	75-69-4
Vinyl Acetate	0.95	ug/l	SW8260C	108-05-4
Vinyl Chloride	0.33	ug/l	SW8260C	75-01-4
Xylenes (Total)	0.39	ug/l	SW8260C	1330-20-7

MDL = Method Detection Limit

Note: The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. The MDL is a laboratory-specific number, dependent (among other things) on the instrumentation used by a particular laboratory and the skill of the operator. As the MDL is re-calculated once per year, this number may change slightly with time.

3.5

Well Installation, Maintenance, and Abandonment Standard Operating Procedures

Groundwater Monitoring Well Abandonment and Plugging Plan

The following steps will be used to plug and abandon monitoring wells, observation wells, and piezometers that are no longer needed or need to be replaced. These steps will minimize the potential for aquifer contamination via the borehole or deleterious affects to the geological environment near the borehole.

This document may be modified or altered to reflect new equipment, techniques, and methods. Appropriate regulatory agencies will be consulted or advised of contemplated changes.

Preliminary Steps Include, If Applicable:

1. Review well construction records for well construction details and repairs.
2. Conduct verification of field data including total well depth and depth to water measurements.
3. Determine the method of drilling and equipment needs.
4. Review health and safety compliance requirements with contractors.

Abandonment Procedures Include The Following:

1. Drilling activities will be coordinated with the Facility on equipment requirements and potential impacts on Facility operations.
2. The water supply to be used for decontamination, drilling, and mixing with plugging materials and/or additives shall be sampled and analyzed or be of a known quality (e.g. drinking water source).
3. All equipment to be used in plugging operations (including all down-hole bits augers, drill stem, tools, samplers, and attachments) must be steam cleaned or pressure washed prior to each use.
4. The concrete apron and protective steel pipe will be removed, if present. All casing will be pulled from the well, if possible. The casing may also have to be drilled out with the drill bit.
5. Depending on well construction, it may be necessary to leave casing in place and produce suitable perforations in the screen and blank casing to allow for plugging material to penetrate the annular space and formation.
6. If possible, the well will be drilled out to the original boring diameter and original depth. Cuttings from the boring will be examined as will penetration rates, etc. The borehole volume will be calculated to assist in confirmation of filling of plugging materials.
7. Flushing with water may be necessary to clear the borehole of debris and foreign matter to achieve an effective seal.

8. Plugging materials such as bentonite or cement will be pumped and/or tremied to the bottom of the well with the discharge line being gradually lifted toward the surface to assure complete filling and prevent bridging. Complete grouting slowly and as one continuous operation to land surface. Allow the plugging material to set a minimum of four hours. If the top of the grout settles to below 6 feet below land surface, then additional grout will be placed to land surface.
9. Actual volume emplaced of all fill materials will be recorded. The specific gravity or (weight) of the grout mixture will be checked periodically during the plugging operations.
10. If the grout settles below the land surface, compacted native soil will be placed in the well from the top of the cement grout to land surface. The soil will be placed in lifts of no more than two feet. Each lift will be manually compacted with a tamping device suitable for the well diameter.
11. Decontaminate (steam clean or pressure wash) all downhole equipment between locations.
12. Properly disposed displaced fluids and other materials such as pulled or drilled out casing and cement seals.

Documentation Procedures

Documentation will include the following information: decommissioning date, field procedures, record of all measurements made (including depths encountered, types and volume of fluids pumped), and other pertinent information.

Monitoring well, Observation well, and Piezometer Maintenance Standard Operating Procedure

Introduction

This Standard Operating Procedure (SOP) describes procedures to be followed at the Lone Mountain Facility in order to ensure the integrity of each monitoring well, observation well, and piezometer is maintained. This SOP included regular well head inspection, field equipment, and instrumentation maintenance, and pump system maintenance. Mitigation steps for wells that require additional attention are also addressed. This SOP will be updated as deemed necessary by the Facility.

Well Head Inspection

Water levels are measured on a regular schedule in all monitoring wells and selected observation wells and piezometers. This procedure requires that field personnel access each well to obtain measurements. During this process, a general inspection of the condition of each well will be made.

This inspection will include the following (which may or may not require maintenance):

- Damaged or missing well caps;
- Well identifications are legible;
- Lock function;
- Condition of annular space;
- Survey reference points are marked, if required;
- Confirm that locks or caps are secured; and,
- Condition of bumper guards, protective casings, concrete pads, and local ground conditions.

Any abnormality is recorded and reported to the Facility Manager or his designee. Patching, painting, and small repair and/or replacements may be done by field personnel.

An annual inspection is made for the total depth of each monitoring well. The dedicated pumps are removed at the time of this inspection. Each total depth reading is compared to the previous reading for significant changes. Significant accumulation of sediment in the bottom of a well will be appropriately removed as deemed necessary by the Facility Manager or his designee. Pumps will be visually inspected and cleaned with deionized water if there is evidence of sediment, chemical, or biological growth.

Additional elevation surveys by a licensed surveyor will be performed following evidence of abnormal or excess settlement, flexed, or broken well casing, or broken seals between components. Abnormalities will recorded and reported to the Facility Manager or his designee.

Pump System Maintenance

Malfunctions of a bladder, purge pump, or controller may be detected during the purging or sampling operations.

1) Each time the pump is removed from the well bore, the following may be completed:
   - The drain hole in the water discharge line will be checked and cleared, if necessary;
   - Bladder sleeves may be replaced, if necessary; and,
   - Fittings will be checked for tightness
2) All replacements or repairs will be accomplished using protective gloves and/or clean tools, being careful to keep all potential contamination from any part of the well or fittings.
3) The manufacturer may be contacted about malfunctioning pumps or controllers. If a pump or controller is deemed non-repairable at the facility, the non-operable unit may be returned to the manufacturer for repair.

Monitoring Well Design and Installation

Introduction

The primary objective of a monitoring well is to provide an access point for measuring groundwater levels and to permit the procurement of groundwater samples that accurately represent in-situ groundwater conditions at the specific point of sampling. The construction materials and their proper installation have a direct impact on the quality of samples and the water levels as represented by the monitoring well. It is necessary to have a thorough knowledge of the diverse types of materials and techniques used in monitoring well construction.

Procedures

Monitoring well construction should be undertaken with minimum disturbance to native soils. The construction materials should be compatible with the anticipated geological and chemical environment. The length and placement of the well screen should allow for fluctuating water levels within the formation. The monitoring well should be completed within the desired zone and sealed to allow for the collection of representative water quality samples.

Prior to installing new monitoring wells at the Lone Mountain Facility, a detailed workplan will be prepared for each new well installation in order to properly address the items stated above. The well installation workplan will also address applicable permit or regulatory requirements.

The well installation workplan will include (but may not be limited to) the following components:

- Monitoring well location and design;
- Monitoring well construction materials;
    - Primary filter pack materials and gradation
    - Well screen materials, diameter, and slot size
    - Riser materials, diameter, and type of joints
    - Annular sealant materials
    - Secondary filter pack materials and gradation, if necessary
- Drilling method;
- Monitoring well installation;

- Assembly of well screen and riser
- Installation of primary filter pack
- Placement of secondary filter pack, if necessary
- Installation of bentonite seal
- Grouting the annular space

- Well protection;
- Well development; and,
- Well testing.

The vertical and horizontal position of each new monitoring well will be surveyed by a licensed surveyor. Each elevation survey will include the elevation (mean sea level) recorded to the nearest 0.01 feet for the top of casing and ground surface or cement pad. Top of casing elevations will be used as the reference point for water level measurements.

After new wells are installed, a complete well construction report will be prepared. The well construction report will describe the actual completion details of each new well and may include a well location map, monitoring well logs, and any other pertinent well installation documents.