UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION 7

IN THE MATTER OF: Oak Grove Village Well Superfund Site La Jolla Cave Complex Franklin County, Missouri TRW Automotive U.S. LLC Respondent Proceeding Under Sections 104, 106(a), 107 and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9604, 9606(a), 9607 and 9622	U.S. EPA Region 7 Docket No. CERCLA-07-2016-0012 **ADMINISTRATIVE SETTLEMENT AGREEMENT AND ORDER ON CONSENT FOR REMOVAL ACTION**

ADMINISTRATIVE SETTLEMENT AGREEMENT AND ORDER ON CONSENT FOR REMOVAL ACTION

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I. JURISDICTION AND GENERAL PROVISIONS

1. This Administrative Settlement Agreement and Order on Consent (Settlement) is entered into voluntarily by the U.S. Environmental Protection Agency (EPA) and TRW Automotive U.S. LLC (Respondent). This Settlement provides for the performance of a removal action by Respondent and the payment of certain response costs incurred by the United States at or in connection with the Oak Grove Village Well Superfund Site, La Jolla Cave Complex, Stanton, Franklin County, Missouri ("Site").

2. This Settlement is issued under the authority vested in the President of the United States by Sections 104, 106(a), 107, and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. §§ 9604, 9606(a), 9607 and 9622 (CERCLA). This authority was delegated to the Administrator of EPA on January 23, 1987, by Executive Order 12580, 52 Fed. Reg. 2923 (Jan. 29, 1987), and further delegated to Regional Administrators by EPA Delegation Nos. 14-14-A (Determinations of Imminent and Substantial Endangerment, Nov. 1, 2001), 14-14-C (Administrative Actions Through Consent Orders, Apr. 15, 1994) and 14-14-D (Cost Recovery Non-Judicial Agreements and Administrative Consent Orders, May 11, 1994). This authority was further redelegated by the Regional Administrator of EPA Region 7 to the Director, Superfund Division, by Regional Delegation R7-14-014-C, Administrative Actions Through Consent Orders (January 1, 1995).

3. EPA has notified the state of Missouri ("State") of this action pursuant to Section 106(a) of CERCLA, 42 U.S.C. § 9606(a).

4. EPA and Respondent recognize that this Settlement has been negotiated in good faith and that the actions undertaken by Respondent in accordance with this Settlement do not constitute an admission of any liability. Respondent does not admit, and retains the right to controvert in any subsequent proceedings other than proceedings to implement or enforce this Settlement, the validity of the findings of facts, conclusions of law, and determinations in Sections IV (Findings of Fact) and V (Conclusions of Law and Determinations) of this Settlement, as well as all facts, conclusions, and determinations set forth in the Action Memorandum attached hereto as Appendix D. Respondent agrees to comply with and be bound by the terms of this Settlement and further agrees that it will not contest the basis or validity of this Settlement or its terms.

II. PARTIES BOUND

5. This Settlement is binding upon EPA and upon Respondent and its successors, and assigns. Any change in ownership or status of Respondent including, but not limited to, any transfer of assets or real or personal property shall not alter the Respondent's responsibilities under this Settlement.

6. Respondent is liable for carrying out all activities required by this Settlement.

7. Each undersigned representative of Respondent certifies that he or she is fully authorized to enter into the terms and conditions of this Settlement and to execute and legally bind Respondent to this Settlement.

8. Respondent shall provide a copy of this Settlement to each contractor hired to perform the Work required by this Settlement and to each person representing Respondent with respect to the Site or the Work, and shall condition all contracts entered into hereunder upon performance of the Work in conformity with the terms of this Settlement. Respondent or its contractors shall provide written notice of the Settlement to all subcontractors hired to perform any portion of the Work required by this Settlement. Respondent shall nonetheless be responsible for ensuring that its contractors and subcontractors perform the Work in accordance with the terms of this Settlement.

III. DEFINITIONS

9. Unless otherwise expressly provided in this Settlement, terms used in this Settlement that are defined in CERCLA or in regulations promulgated under CERCLA shall have the meaning assigned to them in CERCLA or in such regulations. Whenever terms listed below are used in this Settlement or its attached appendices, the following definitions shall apply:

"Action Memorandum" shall mean the EPA Action Memorandum relating to the Site signed by the EPA Region 7, Director, Superfund Division, and all attachments thereto. The Action Memorandum is attached as Appendix D.

"Affected Property" shall mean all real property at the Site and any other real property where EPA determines, at any time, that access or land, water, or other resource use restrictions are needed to implement the removal action, as generally depicted in Appendix A, including the portion of Meramec Caverns owned by Meramec Caverns Enterprises, Inc. and the overlying surface.

"CERCLA" shall mean the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9601-9675.

"Day" or "day" shall mean a calendar day. In computing any period of time under this Settlement, where the last day would fall on a Saturday, Sunday, or Federal or State holiday, the period shall run until the close of business of the next working day.

"Effective Date" shall mean the effective date of this Settlement as provided in Section XXX (Effective Date).

"EPA" shall mean the U.S. Environmental Protection Agency and its successor departments, agencies, or instrumentalities.

"EPA Hazardous Substance Superfund" shall mean the Hazardous Substance Superfund established by the Internal Revenue Code, 26 U.S.C. § 9507.

"Future Response Costs" shall mean all costs, including, but not limited to, direct and indirect costs, that the United States incurs after the Effective Date in reviewing or developing deliverables submitted pursuant to this Settlement, in overseeing implementation of the Work, or otherwise implementing, overseeing, or enforcing this Settlement, including

but not limited to, payroll costs, contractor costs, travel costs, laboratory costs, the costs incurred pursuant to Section IX (Property Requirements) (including, but not limited to, cost of attorney time and any monies paid to secure or enforce access, including, but not limited to, the amount of just compensation), Section XIII (Emergency Response and Notification of Releases), Paragraph 124 (Work Takeover), Paragraph 145 (Access to Financial Assurance), Section XV (Dispute Resolution), and all litigation costs. Future Response Costs shall also include future Agency for Toxic Substances and Disease Registry ("ATSDR") costs regarding the Site.

"Interest" shall mean interest at the rate specified for interest on investments of the EPA Hazardous Substance Superfund established by 26 U.S.C. § 9507, compounded annually on October 1 of each year, in accordance with 42 U.S.C. § 9607(a). The applicable rate of interest shall be the rate in effect at the time the interest accrues. The rate of interest is subject to change on October 1 of each year. Rates are available online at http://www2.epa.gov/superfund/superfund-interest-rates.

"MDHSS" shall mean the Missouri Department of Health and Senior Services and any successor departments of agencies of the State.

"MDNR" shall mean the Missouri Department of Natural Resources and any successor departments or agencies of the State.

"National Contingency Plan" or "NCP" shall mean the National Oil and Hazardous Substances Pollution Contingency Plan promulgated pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, codified at 40 C.F.R. Part 300, and any amendments thereto.

"Non-Settling Owner" shall mean any person, other than Respondent, that owns or controls any Affected Property, including Meramec Caverns Enterprises, Inc. ("MCE"). The clause "Non-Settling Owner's Affected Property" means Affected Property owned or controlled by a Non-Settling Owner.

"Paragraph" shall mean a portion of this Settlement identified by an Arabic numeral or an upper or lower case letter.

"Parties" shall mean EPA and Respondent.

"Post-Removal Site Control" shall mean actions necessary to ensure the effectiveness and integrity of the removal action to be performed pursuant to this Settlement consistent with Sections 300.415(*l*) and 300.5 of the NCP and "Policy on Management of Post-Removal Site Control" (OSWER Directive No. 9360.2-02, Dec. 3, 1990).

"RCRA" shall mean the Solid Waste Disposal Act, 42 U.S.C. §§ 6901-6992 (also known as the Resource Conservation and Recovery Act).

"RI/FS OU2" shall mean the Remedial Investigation/Feasibility Study performed under the Administrative Order on Consent for Remedial Investigation/Feasibility Study Docket No. CERCLA-07-2009-014.

"Respondent" shall mean TRW Automotive U.S. LLC.

"Section" shall mean a portion of this Settlement identified by a Roman numeral.

"Settlement" shall mean this Administrative Settlement Agreement and Order on Consent and all appendices attached hereto (listed in Section XXIX Integration/Appendices). In the event of conflict between this Settlement and any appendix, this Settlement shall control.

"Site" shall mean the Oak Grove Village Well Superfund Site, in Franklin County, Missouri and depicted generally on the map attached as Appendix B.

"State" shall mean the state of Missouri.

"Statement of Work" or "SOW" shall mean the document(s) describing the activities Respondent must perform to implement the removal action pursuant to this Settlement, and any modifications made thereto in accordance with this Settlement.

"Transfer" shall mean to sell, assign, convey, lease, mortgage, or grant a security interest in, or where used as a noun, a sale, assignment, conveyance, or other disposition of any interest by operation of law or otherwise.

"United States" shall mean the United States of America and each department, agency, and instrumentality of the United States, including EPA.

"Waste Material" shall mean (a) any "hazardous substance" under Section 101(14) of CERCLA, 42 U.S.C. § 9601(14); (b) any pollutant or contaminant under Section 101(33) of CERCLA, 42 U.S.C. § 9601(33); and (c) any "solid waste" under Section 1004(27) of RCRA, 42 U.S.C. § 6903(27).

"Work" shall mean all activities and obligations Respondent is required to perform under this Settlement except those required by Section XI (Record Retention).

IV. EPA FINDINGS OF FACT

Site Description

10. The Oak Grove Village Well Superfund Site is located in Franklin County, Missouri. The Site was proposed for the National Priorities List on September 13, 2001, and the listing became final pursuant to CERCLA Section 105, 42 U.S.C. § 9605, on September 2, 2002.

11. Oak Grove Village ("OGV") is a small rural community, with a population of 382. The OGV municipal well #1 ("OGV01") was drilled in 1964 and was the only source of drinking water for the village residents for a number of years. The MDNR Public Drinking Water Program detected trichloroethylene ("TCE") contamination in OGV01 on June 10, 1986, at 6 parts per billion ("ppb") during routine water sampling.

12. In December 2002, a new municipal well #2 ("OGV02") was drilled; however, contamination prevented its use until an air stripper was installed and deemed operational. OGV02, with its air stripper in place, began operation and replaced OGV01 as the source of drinking water for OGV in April 2005.

13. The Site has been subdivided into two Operable Units. Operable Unit 1 ("OU1") includes the contamination in the area of the Oak Grove Village Well, including impacted wells in Sullivan. Operable Unit 2 ("OU2") includes the closed Sullivan municipal landfill, as well as nearby wells and springs impacted by contamination from the landfill. Both operable units contribute to the La Jolla Spring Cave Complex which provides groundwater drainage for the Oak Grove/Sullivan area. The tourist attraction "show cave" known as Meramec Caverns is located within the La Jolla Spring Cave Complex.

14. The only significant sources EPA has found to be impacting the Ozark Aquifer are the former TRW/Ramsey facility located at 300 Ramsey Street ("TRW/Ramsey facility") in Sullivan, Franklin County, Missouri and the closed Sullivan Landfill. Contamination in OU1 is originating from the former TRW/Ramsey facility which is currently working with the MDNR Resource Conservation Recovery Act Corrective Action program to address the TCE contamination originating from its property and the closed Sullivan Landfill which is being investigated by the EPA Superfund program under OU2.

Early Site Investigations

15. The closed 28-acre Sullivan Landfill is owned by the City of Sullivan and is located east of Highway 185 and directly south of Emma Lane in a residential area. Adjacent to the landfill on the east is the Voss Meat Packing Plant. The landfill is approximately three miles north of downtown Sullivan and approximately 3,000 feet northeast of the OGV municipal wells. Other nearby wells include City of Sullivan Wells #9 and #10.

16. From 1950 until 1983, TRW, Inc. ("TRW") operated an automobile piston manufacturing plant at the TRW/Ramsey facility. The TRW/Ramsey facility encompasses approximately 7 acres. A chrome plating system was operated at the facility and various organic solvents and petroleum-based products were used.

17. Since initial detection, the TCE concentrations detected in OGV01 have ranged from 1.5 (November 15, 2000) to 99.6 µg/l (April 29, 2004). Investigations were conducted to determine the location and extent of the contaminant plumes in groundwater impacting area wells. The sample results from area wells determined that TCE and other chemicals of potential concern, such as tetrachloroethylene ("PCE") and the degradation products of TCE, had contaminated private (residential and commercial/industrial), and municipal wells, as well as a spring in the OGV area.

18. A MDNR Remedial Investigation/Feasibility Study ("RI/FS") was conducted in a phased approach to determine the nature and extent of the contamination detected in OGV01, to identify possible sources of the contamination in groundwater, and to identify Potentially Responsible Parties. The Phase I RI began in October 1999. The Phase I RI evaluated existing

data, collected additional data to narrow data gaps, determined the existence and location of contamination, and identified additional potential source areas. Area-wide sampling of private, commercial, and municipal wells, as well as springs and creeks, detected TCE and other Volatile Organic Compounds in multiple wells and one spring. The information obtained during the Phase I RI provided additional data to better define the extent of the area-wide contamination.

19. The Phase II RI began in April 2002, and it was completed in August 2005. The Phase II RI activities consisted of continued sampling of private, commercial, and municipal wells, as well as area springs. Additional field activities included: (i) investigating and sampling the OGV and Sullivan sanitary sewers, (ii) installing and sampling groundwater monitoring wells, and (iii) sampling possible additional source areas.

20. The data collected during the Phase II RI narrowed the data gaps and better defined the location and extent of the contaminant plumes. A FS and Proposed Remedial Action Plan were completed based on the conclusions of the Phase II RI. However, upon review the EPA and MDNR decided additional Site work was needed to fill in remaining data gaps and to adequately define the Site. In order to fill in the data gaps, the Site was divided into two OUs: (i) Operable Unit 1 consisted of the OGV wells, the Highway AF wells, and the area west and south of the OGV wells, and (ii) Operable Unit 2 consisted of the closed Sullivan Landfill and/or other unknown potential source areas, wells and springs around the closed Sullivan Landfill, the Meramec River, and the La Jolla Spring Cave Complex.

Additional OU1 Investigations

21. The Post-Phase II RI (2005 to June 2007), which was a continuation of the Phase II RI investigation, included source area investigations and the additional characterization, installation, and/or completion of private, municipal, and monitoring wells. The additional field activities included: (i) sampling Winsel Creek and the Meramec River, (ii) characterizing OGV01, (iii) sampling OGV01 and OGV02, (iv) installing and sampling additional groundwater monitoring wells, (v) sampling previously known potential source areas, and (vi) sampling possible additional source areas.

22. After completion of the Post-Phase II RI, EPA continued efforts to fill data gaps identified for OU1 during previous site investigations. Several monitoring wells that were to be installed during the OU1 RI were not completed because of poor drilling conditions. Further, several possible TCE source areas in the vicinity of OGV01 and OGV02 were not identified until the RI was nearly complete. In addition, the findings of the RI were inconclusive regarding the source of TCE contamination in the Highway AF Well Area.

23. The EPA efforts to fill the data gaps consisted of various investigations performed by the United States Geological Survey ("USGS"). The USGS investigations included: (i) sampling at eight additional potential source areas; (ii) installing and sampling one monitoring well; (iii) collecting air and water samples at the La Jolla Spring Cave Complex; and (iv) collecting groundwater samples and measuring water levels at monitoring wells and private residential wells. Soil sampling and tree core samples showed that there was no indication that

these additional areas investigated were sources of the TCE contamination in the OGV wells or La Jolla Spring.

TRW-Ramsey Facility Investigations

24. Since 1983, TRW has been performing investigations and remediation activities at the TRW/Ramsey facility. On April 1, 1993, TRW and the current owners of the TRW/Ramsey facility entered into a RCRA Administrative Order on Consent ("AOC") with the EPA RCRA program. During the corrective action process, four interim measures plans were completed which include the groundwater monitoring plan, the surface impoundments soils report, the drinking water contingency plan, and the pump and treatment plan.

25. The Resource Conservation and Recovery Act Facility Investigation ("RFI") confirmed the presence of TRW/Ramsey facility-related contaminants in groundwater above applicable groundwater regulatory guidance criteria and assessed the horizontal and vertical extent of the groundwater contamination caused by releases from the former TRW/Ramsey facility. To date, TRW has installed a total of 41 monitoring wells at shallow (150 feet), intermediate (350 feet), and deep (550 feet) levels on and surrounding the facility property, and has conducted geophysical logging of the subsurface in selected monitoring wells.

26. The RFI activities also determined that the primary contaminants of concern (trichloroethylene, 1,2-dichloroethene, 1,2-dichloroethane, lead and chromium) were present above applicable groundwater regulatory guidance criteria at various depths within the aquifer that serves as the water supply for the City of Sullivan. At present, there are no known completed exposure pathways to contaminated drinking water above regulatory standards associated with this site because the City of Sullivan and TRW both sample and monitor drinking water supply quality from the City of Sullivan's wells to assure that the water supply meets State Water Quality Standards. The City and TRW provide quarterly monitoring reports to federal and state officials.

Additional OU2 Investigations

27. In 1970, the City of Sullivan began landfill operations with the disposal of municipal and industrial wastes in an old ravine fill area. From 1970 to 1975, both industrial and municipal wastes were accepted in the ravine. The landfill was first permitted by MDNR in 1974.

28. Standard operations at the landfill ravine included crushing drums intact and/or pouring the contents of the drums into the ravine before crushing them.

29. In 1975, a plan was submitted to phase out the ravine operation and develop trench cells in the northern portion of the landfill. The ravine and trench fill areas were separated by an east-west ridge.

30. In 1978, MDNR issued a permit for trench-type disposal in an 8.5-acre area. In 1982, an additional 0.5-acre trench area was permitted by MDNR.

31. The trench fill area included the development of a series of shallow trenches approximately 25 feet wide and 200 feet long. During trench construction, the City included an industrial waste cell to store approximately 200 drums. Landfill records indicate that drums of barium chromate and TCE/oil and grease mixtures were deposited in the industrial waste cell.

32. The landfill ceased accepting wastes in 1983.

33. In August 1990, the City entered into an investigation with the USGS as a result of samples taken from the leachate collected at the Sullivan Landfill showing hazardous substances, as well as groundwater samples from several area wells, including OGV01, a former Sullivan municipal well, and the landfill monitoring wells.

34. During the investigation, USGS sampled three of the largest seeps from the Sullivan Landfill for VOCs and metals. Results indicated the presence of PCE from 8 to 19 micrograms per liter (µg/l) and TCE from 150 to 370 µg/l. TCE degradation products, Freons, and other compounds were also detected.

35. In September 1990, MDNR issued the City a citation based upon available sampling results and the annual solid waste disposal facility inspections. In response to the MDNR citation, the City constructed berms around the cited seeps to help prevent off-site migration of leachate.

36. In October 1990, Sullivan issued a Notice of Liability letter to the Ramsey Corporation (owned by TRW, Inc.) and Meramec Industries, Inc. as primary contributors of hazardous waste in the landfill. The City estimated that TRW deposited 7,500 barrels of hazardous waste in the landfill and Meramec Industries deposited 356 barrels of hazardous waste.

37. After the City's Notice of Liability letters were mailed out, a Potentially Responsible Party ("PRP") group was formed to address contamination from the Sullivan Landfill. This group was comprised of TRW, Meramec Industries, Inc. and the City of Sullivan. ABB-Environmental Services (ABB-ES) was contracted by TRW to conduct work at the site on behalf of the PRP group.

38. In 1991, the Missouri Department of Geology and Land Survey performed five dye tracer tests in the Sullivan area. One of these tracers was injected into a sinkhole at the closed Sullivan landfill. The tracer was identified in La Jolla Spring 179 days after the tracer was released into the sinkhole.

39. In May 1992, prior to landfill closure, approximately 149 55-gallon drums and 32 5-gallon buckets that had been deposited in the industrial waste cell were removed by ABB-ES under contract with the PRP Group.

40. The PRP Group installed six monitoring wells at the landfill to determine if contaminants were migrating from the site. The shallowest monitoring well (MW-105) was drilled to 177 feet below ground surface (bgs); the deepest monitoring well (MW-102A) was drilled to an approximate depth of 275 feet.

41. The City began construction of a landfill cap and associated leachate collection system in 1994. Construction was completed in 1995, and MDNR approved landfill closure in 1996.

42. Several contaminants, including TCE and Freon 11, have been detected in all six of the landfill monitoring wells (MW101, MW102A, MW102B, MW103, MW104, MW105) since their installation in 1992. TCE concentrations have been consistently detected from 0.5 µg/l to 6.6 µg/l, and Freon 11 has been detected from 1.4 µg/l to 197 µg/l.

43. The Voss well (354 feet deep), a private well located adjacent to the landfill, has had TCE detections during every sampling event since 2000 at levels ranging from 1.6 to 5.4 µg/l, and Freon 11 at levels from 15 µg/l to 120 µg/l.

44. Contaminants, including TCE, have been detected at depth within the landfill monitoring wells, indicating contamination underneath the landfill is deeper than 275 feet (the deepest monitoring well at the landfill) and could be impacting the area groundwater at depth.

45. In 2005, during the Phase II Remedial Investigation (RI) for the Oak Grove Village Well Superfund Site, MDNR drilled three deep monitoring wells. One of these wells was located 250 feet south of the Sullivan landfill. The well was drilled 501 feet bgs, for a total depth of 505 feet. The open annulus of the well is referred to as MW-1A and the deeper open-hole section below the riser from 349 to 505 feet bgs is referred to as MW-1.

46. In April 2006, MDNR took samples from MW-1A and MW-1. Both field analysis and laboratory results showed small concentrations of TCE and other contaminants in MW-1A. TCE was not detected in MW-1.

47. During Phase I and Phase II of the RI, MDNR conducted periodic sampling of private wells near the landfill. Several contaminants, including TCE and Freon 11, were routinely detected in private wells located west of the closed Sullivan landfill. Two of these private wells had TCE detections above the maximum contaminant level ("MCL") of 5 µg/l and were provided whole-house filtration systems by EPA.

48. The detection of contaminants in MW-1A, the landfill monitoring wells, and nearby private wells indicates that releases at the landfill are impacting shallow groundwater in the upper aquifer. These contaminant releases have been detected in off-site wells, both west and south of the landfill.

49. In 2009, EPA and TRW entered into an order to conduct a RI/FS at the landfill. The Phase 1 Site Characterization at the site consisted of evaluating whether the landfill was a source of TCE in groundwater and to sample surface water and springs in the area to determine if they had been impacted by TCE via groundwater at the landfill. Two other parties, the City of Sullivan and Meramec Group, Inc., were issued Unilateral Administrative Orders directing them to assist in the performance of the RI/FS at the Sullivan landfill.

50. Springs in the area around the landfill were sampled twice in May and October 2010 during the landfill RI. The only detections of VOCs were TCE at La Jolla Spring.

51. Two landfill RI groundwater monitoring wells were also installed on the landfill footprint. One was located next to a sinkhole in the middle of the landfill, and one to the northwest in the direction of private wells with known TCE detections. Groundwater sampling showed that both monitoring wells contained levels of TCE below the federal MCL of 5.0 µg/L.

La Jolla Cavern

52. La Jolla Spring is a cave complex located approximately two miles east of the Sullivan Landfill and approximately 4 miles northeast of the TRW/Ramsey facility in Sullivan, Missouri. With a flow rate of approximately 4 cubic feet per second, the spring serves as a drainage point for the Sullivan and Oak Grove Village area.

53. The spring flows through a large show cave owned and operated by a private owner and open to paying customers. The spring flows more than one half mile through the cave complex. Water samples taken from different locations along the stream indicate that VOC concentrations in the stream decrease as the water flows through the cave complex.

54. After the numerous investigations from 1987 through 2015 for the Oak Grove Village Site, EPA has concluded that TCE contamination in OU1 was originating from the TRW/Ramsey facility and the Sullivan Landfill and then transported through karstic features and the pumping of municipal wells to other areas in the Sullivan/Oak Grove Village area. Dye trace results from the 1990s, the size of the source needed to sustain the amount of TCE in the La Jolla Cave Spring Complex over many years, the size of the spring (e.g. its recharge area), as well as the suite of contaminants found in the cave air and the cave water, suggest that a groundwater pathway exists from the Sullivan Landfill and the TRW/Ramsey facility to the La Jolla Spring Cave Complex.

55. Concentrations of TCE and several other VOCs have been detected in water samples from La Jolla Spring since the early 1990s. Concentrations in spring water samples have ranged from less than 1.0 to 12.0 µg/l in samples collected by the USGS, MDNR, and a consultant for a PRP. Other VOCs detected have included cis-1,2-dichloroethene, Freon-11, Freon 12, and Freon 21.

56. From October 2002 to January 2005, EPA and MDNR conducted six sampling events (air and water) in the La Jolla Spring Cave Complex. Sample results detected the presence of Freon 12; Freon 11; 1,1-dichloroethene; methylene chloride; cis-1,2-dichloroethene; TCE; toluene; m,p-xylene; 1,4-dichlorobenzene; PCE; ethanol; 2-propanol; and acetone. In the cave air, Freon 11 was detected as high as 270 $\mu g/m^3$ and TCE was detected as high as 1,700 $\mu g/m^3$. Water samples within the La Jolla Spring Cave Complex detected Freon 11 as high as 2.13 µg/l and TCE as high as 12.6 µg/l.

57. Air sampling conducted for EPA within Meramec Caverns and the Meramec Caverns Gift Shop/Restaurant from March 2013 until November 2015, continued to show the presence of the same contaminants that were detected from 2002-2005. TCE was detected in air as high as 660 $\mu g/m^3$ in the Jungle Room area of Meramec Caverns in October 2015. Cave tour

guides, gift shop/restaurant personnel and paying customers have been subjected to exposures to the TCE contaminated air.

58. The Missouri Department of Health and Senior Services ("MDHSS") issued a Health Consultation regarding the TCE air concentrations in Meramec Caverns and the Meramec Caverns Gift Shop/Restaurant on December 12, 2014. The Health Consultation included the following recommendations to EPA: (i) Inform workers of elevated TCE concentrations in the cave air and the potential health risks associated with TCE inhalation. DHSS recommends notification be made as soon as possible; and (ii) Implement permanent measures to mitigate vapor intrusion into the cave as soon as possible and consider implementing temporary measures to prevent TCE exposure to female workers of childbearing age until permanent mitigation solutions are in place. And further, that once a permanent solution was in place, to conduct periodic monitoring to confirm that mitigation solutions are effective in reducing contaminant levels.

59. In March 2015, the EPA and the MDNR met with TRW to encourage TRW to work cooperatively with MCE to study and implement ways to reduce TCE in the air and water within the cave. It was suggested that TRW implement specific actions as soon as practicable to reduce and/or eliminate the TCE in the air within the cave and gift shop. As requested, by EPA and the MDNR, TRW has worked cooperatively with MCE to reduce TCE in the air and water within the cave. Some of the actions taken to date include: (i) upgrades to the existing HVAC system to include a 10% fresh air exchange; (ii) installation of a set of airlock doors to separate air in contact with the stream from the rest of the cave tour; (iii) thermal imaging to assist in sealing cracks and fissures contributing to the TCE escaping through the airlock doors; and (iv) enlarging the amphitheater entrance to increase air flow throughout the cave system. These actions have had a significant impact on TCE concentrations on areas in front of the airlock doors. However, additional work and better controls are needed to ensure TCE concentrations can be consistently attained below a level of health concern.

60. Air sampling activities were performed within Meramec Caverns and the gift shop/restaurant throughout 2015. The sampling results revealed that the efforts had not been successful in adequately mitigating the TCE air levels to the extent necessary to be protective of the health of workers. On February 1, 2016, the ATSDR issued a follow-up letter to the 2014 Health Consultation. The ATSDR letter states as follows with respect to Meramec Caverns: ATSDR recommends that exposures be stopped until such time as air TCE concentrations in the cave complex are consistently below a level of concern.

61. MCE has employees that have provided tours of Meramec Caverns or have worked in the gift shop/restaurant. Individuals working in the cave have been exposed to TCE concentrations greater than levels of health concern. Potential risks to tour guides are greater than other types of human receptors (gift shop workers or cave visitors) due to the length of time guides spend in portions of the cave where higher TCE concentrations in air have been detected.

62. For noncancer health effects, EPA has concluded that under exposure conditions at this Site the levels of TCE that can present a health threat for long-term exposure are 8 $\mu g/m^3$ based on adverse immune and kidney effects, and for short-term exposure are 6 $\mu g/m^3$ based on

development effects. When EPA evaluates noncancer health effects, a hazard quotient greater than 1 indicates unacceptable risks. The hazard quotients calculated by EPA for cave workers significantly exceed 1 for noncancer health effects for both short-term and long-term exposures.

63. As an interim measure, TRW has installed air cleaners in the gift shop and other areas of Meramec Caverns in front of the air lock doors. Since installation of the air cleaners, TCE concentrations for the areas in front of the air lock doors have generally been below levels of health concern. In addition, permanent airlocks have been installed, improvements have been completed to the entrance to the cave, and two vent wells have been installed.

64. Respondent does not admit, and retains the right to controvert in any subsequent proceedings other than proceedings to implement or enforce this Settlement, the validity of the Findings of Fact (including any conclusions and/or inferences drawn therefrom) set forth above.

V. CONCLUSIONS OF LAW AND DETERMINATIONS

65. Based on the Findings of Fact set forth above, and the administrative record, EPA has determined that:

a. The Oak Grove Village Well Superfund Site, is a "facility" as defined by Section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

b. The contamination found at the Site, as identified in the Findings of Fact above, includes a "hazardous substance" as defined by Section 101(14) of CERCLA, 42 U.S.C. § 9601(14).

c. Respondent is a "person" as defined by Section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

d. Respondent is a responsible party under Section 107(a) of CERCLA, 42 U.S.C. § 9607(a).

e. The conditions described in Paragraphs 10 through 63 of the Findings of Fact above constitute an actual or threatened "release" of a hazardous substance from the facility as defined by Section 101(22) of CERCLA, 42 U.S.C. § 9601(22).

f. The conditions described in Paragraph 57 of the Findings of Fact above may constitute an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance from the facility within the meaning of Section 106(a) of CERCLA, 42 U.S.C. § 9606(a). EPA determined in the Action Memorandum, that the conditions at the Site described in Paragraph 57 of the Findings of Fact above may constitute an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance from the facility within the meaning of Section 106(a) of CERCLA, 42 U.S.C. § 9606(a).

g. The removal action required by this Settlement is necessary to protect the public health, welfare, or the environment and, if carried out in compliance with the terms of this Settlement, will be consistent with the NCP, as provided in Section 300.700(c)(3)(ii) of the NCP.

VI. SETTLEMENT AGREEMENT AND ORDER

66. Based upon the Findings of Fact, Conclusions of Law, and Determinations set forth above, and the administrative record, it is hereby Ordered and Agreed that Respondent shall comply with all provisions of this Settlement, including, but not limited to, all appendices to this Settlement and all documents incorporated by reference into this Settlement.

VII. DESIGNATION OF CONTRACTOR, PROJECT COORDINATOR, AND ON-SCENE COORDINATOR

67. Respondent has retained, and EPA has not disapproved, Arcadis as its contractor to perform the Work. In addition, as set forth in the Work Plans attached as Appendix C, MCE is tasked with performing and/or overseeing certain aspects of the Work on behalf of the Respondent. EPA retains the right to disapprove of any other contractors and/or subcontractors retained by Respondent. The EPA has approved Respondent's contractors that are currently performing work under the RI/FS OU2 Order. If EPA disapproves of a selected contractor or subcontractor, Respondent shall retain a different contractor or subcontractor and shall notify EPA of that contractor's or subcontractor's name and qualifications within ten (10) days after EPA's disapproval. With respect to any proposed contractor, Respondent shall demonstrate that the proposed contractor demonstrates compliance with ASQ/ANSI E4:2014 "Quality management systems for environmental information and technology programs – Requirements with guidance for use" (American Society for Quality, February 2014), by submitting a copy of the proposed contractor's Quality Management Plan (QMP). The QMP should be prepared in accordance with "EPA Requirements for Quality Management Plans (QA/R-2)" (EPA/240/B-01/002, Reissued May 2006) or equivalent documentation as determined by EPA. The qualifications of the persons undertaking the Work for Respondent shall be subject to EPA's review for verification that such persons meet minimum technical background and experience requirements.

68. Respondent has designated, and EPA has not disapproved, the following individual as Project Coordinator, who shall be responsible for administration of all actions by Respondent required by this Settlement: John Shonfelt, P.G.. To the greatest extent possible, the Project Coordinator shall be present on Site or readily available during Site work. EPA retains the right to disapprove of the designated Project Coordinator. If EPA disapproves of the designated Project Coordinator, Respondent shall retain a different Project Coordinator and shall notify EPA of that person's name, address, telephone number, email address, and qualifications within ten (10) days following EPA's disapproval.

69. EPA has designated Tonya Howell as the Remedial Project Manager ("RPM"), and Doug Ferguson as its On-Scene Coordinator ("OSC"). EPA and Respondent shall have the right, subject to Paragraph 67, to change their respective designated OSC or Project Coordinator.

Respondent shall notify EPA ten (10) days before such a change is made. The initial notification by Respondent may be made orally, but shall be promptly followed by a written notice.

70. The RPM and OSC shall be responsible for overseeing Respondent's implementation of this Settlement. The RPM and the OSC shall have the authority vested in an OSC by the NCP, including the authority to halt, conduct, or direct any Work required by this Settlement, or to direct any other removal action undertaken at the Site. Absence of the RPM or OSC from the Site shall not be cause for stoppage of work unless specifically directed by the RPM or OSC.

VIII. WORK TO BE PERFORMED

71. Respondent shall perform all actions necessary to implement the Action Memorandum and consistent with the Work Plans attached hereto as Appendix C. The actions generally include, but are not limited to, installation of vent wells in the cave, an evaluation of potential modifications of the HVAC system in the gift shop, installation of portable air cleaners, upgrades to the air lock doors in the cave and eliminating the use of cave spring water in cave operations.

72. For any regulation or guidance referenced in the Settlement, the reference will be read to include any subsequent modification, amendment, or replacement of such regulation or guidance. Such modifications, amendments, or replacements apply to the Work only after Respondent receives notification from EPA of the modification, amendment, or replacement.

73. Work Plan and Implementation.

a. Respondent has submitted work plans to EPA pursuant to the Administrative Order on Consent for Remedial Investigation/Feasibility Study (RI/FS) Docket No. CERCLA-07-2009-014. The RI/FS OU2 work plans are attached as Appendix C. That work is currently being implemented by Respondent and MCE and will continue to be implemented as the Work under this Settlement.

b. No later than November 1, 2016, in accordance with Paragraph 74 (Submission of Deliverables), Respondent shall submit an evaluation of the HVAC system in the gift shop to determine whether modifications of the HVAC system are necessary to achieve the level of health concern specified in the Action Memorandum.

c. Respondent shall continue to implement the Work in accordance with the schedule included in the Work Plans attached as Appendix C. If MCE, or the then-current owner of Meramec Caverns, stops cooperating with implementation of the Work, Respondent and EPA shall negotiate revisions to the Work schedule to account for MCE's noncooperation. Respondent shall not commence or perform any Work except in conformance with the terms of this Settlement.

d. Respondent's obligations to continue implementation of the Work Plans attached as Appendix C shall cease if MCE, or the then-current owner of Meramec Caverns, elects to discontinue offering tours of Meramec Caverns to the public.

e. Unless otherwise provided in this Settlement, any additional deliverables that require EPA approval under the Work Plans shall be reviewed and approved by EPA in accordance with this Paragraph.

74. Submission of Deliverables.

a. General Requirements for Deliverables.

(1) Except as otherwise provided in this Settlement, Respondent shall direct all submissions required by this Settlement to the RPM, Tonya Howell, U.S. Environmental Protection Agency, Region 7, 11201 Renner Blvd., Lenexa, Kansas 66219. Respondent shall submit all deliverables required by this Settlement, the attached SOW, or any approved work plan to EPA in accordance with the schedule set forth in such plan.

(2) Respondent shall submit all deliverables in electronic form. Technical specifications for sampling and monitoring data and spatial data are addressed in Paragraph 74.b. All other deliverables shall be submitted to EPA in the form specified by the RPM. If any deliverable includes maps, drawings, or other exhibits that are larger than 8.5 x 11 inches, Respondent shall also provide EPA with paper copies of such exhibits.

b. Technical Specifications for Deliverables.

(1) Sampling and monitoring data should be submitted in standard Regional Electronic Data Deliverable (EDD) format: Microsoft Excel. Other delivery methods may be allowed if electronic direct submission presents a significant burden or as technology changes.

(2) Spatial data, including spatially-referenced data and geospatial data, should be submitted: (a) in the ESRI File Geodatabase format or Esri Shapefiles; and (b) as unprojected geographic coordinates in decimal degree format using North American Datum 1983 (NAD83) or World Geodetic System 1984 (WGS84) as the datum. If applicable, submissions should include the collection method(s). Projected coordinates may optionally be included but must be documented. Spatial data should be accompanied by metadata, and such metadata should be compliant with the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata and its EPA profile, the EPA Geospatial Metadata Technical Specification. An add-on metadata editor for ESRI software, the EPA Metadata Editor (EME), complies with these FGDC and EPA metadata requirements and is available at https://edg.epa.gov/EME/.

(3) Each file must include an attribute name for each site unit or sub-unit submitted. Consult http://www.epa.gov/geospatial/policies.html for any further available guidance on attribute identification and naming.

(4) Spatial data submitted by Respondent does not, and is not intended to, define the boundaries of the Site.

75. Health and Safety Plan. Respondent submitted to EPA on April 12, 2016 a revised RI/FS OU2 Health and Safety Plan. The revised RI/FS OU2 Health and Safety Plan shall apply to the Work performed under this Settlement.

76. Quality Assurance, Sampling, and Data Analysis.

a. Respondent shall use quality assurance, quality control, and other technical activities and chain of custody procedures for all samples consistent with "EPA Requirements for Quality Assurance Project Plans (QA/R5)" EPA/240/B-01/003 (March 2001, reissued May 2006), "Guidance for Quality Assurance Project Plans (QA/G-5)" EPA/240/R-02/009 (December 2002), and "Uniform Federal Policy for Quality Assurance Project Plans," Parts 1-3, EPA/505/B-04/900A-900C (March 2005).

b. Field Sampling Plan. The Work Plans attached as Appendix C contain Field Sampling Plans which shall apply to the Work performed under this Settlement. A Quality Assurance Project Plan ("QAPP") has been submitted to EPA under the RI/FS OU2 Order and shall apply to the Work performed under this Settlement. If a QAPP addendum is necessary, it is to be consistent with the Work Plans attached as Appendix C, the NCP and applicable guidance documents, including, but not limited to, "Guidance for Quality Assurance Project Plans (QA/G-5)" EPA/240/R-02/009 (December 2002), "EPA Requirements for Quality Assurance Project Plans (QA/R-5)" EPA 240/B-01/003 (March 2001, reissued May 2006), and "Uniform Federal Policy for Quality Assurance Project Plans," Parts 1-3, EPA/505/B-04/900A-900C (March 2005). Upon its approval by EPA, the Field Sampling Plan and any QAPP addendums shall be incorporated into and become enforceable under this Settlement.

c. Respondent shall ensure that EPA and State personnel and their authorized representatives are allowed access at reasonable times to all laboratories utilized by Respondent in implementing this Settlement. In addition, Respondent shall ensure that such laboratories shall analyze all samples submitted by EPA pursuant to the QAPP for quality assurance, quality control, and technical activities that will satisfy the stated performance criteria as specified in the QAPP and that sampling and field activities are conducted in accordance with EPA's "Field Operations Group Operational Guidelines for Field Activities" (http://www.epa.gov/region8/qa/FieldOperationsGroupOperationalGuidelinesForFieldActivities.pdf) and "EPA QA Field Activities Procedure" (http://www.epa.gov/irmpoli8/policies/2105-p-02.pdf). Respondent shall ensure that the laboratories it utilizes for the analysis of samples taken pursuant to this Settlement meet the competency requirements set forth in EPA's "Policy to Assure Competency of Laboratories, Field Sampling, and Other Organizations Generating Environmental Measurement Data under Agency-Funded

Acquisitions" (http://www.epa.gov/fem/pdfs/fem-lab-competency-policy.pdf) and that the laboratories perform all analyses according to accepted EPA methods. Accepted EPA methods consist of, but are not limited to, methods that are documented in the EPA's Contract Laboratory Program (http://www.epa.gov/superfund/programs/clp/), SW 846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm), "Standard Methods for the Examination of Water and Wastewater" (http://www.standardmethods.org/), 40 C.F.R. Part 136, "Air Toxics - Monitoring Methods" (http://www.epa.gov/ttnamti1/airtox.html)."

d. However, upon approval by EPA, Respondent may use other appropriate analytical method(s), as long as (i) quality assurance/quality control (QA/QC) criteria are contained in the method(s) and the method(s) are included in the QAPP, (ii) the analytical method(s) are at least as stringent as the methods listed above, and (iii) the method(s) have been approved for use by a nationally recognized organization responsible for verification and publication of analytical methods, e.g., EPA, ASTM, NIOSH, OSHA, etc. Respondent shall ensure that all laboratories it uses for analysis of samples taken pursuant to this Settlement have a documented Quality System that complies with ASQ/ANSI E4:2014 "Quality management systems for environmental information and technology programs - Requirements with guidance for use" (American Society for Quality, February 2014), and "EPA Requirements for Quality Management Plans (QA/R-2)" EPA/240/B-01/002 (March 2001, reissued May 2006), or equivalent documentation as determined by EPA. EPA may consider Environmental Response Laboratory Network (ERLN) laboratories, laboratories accredited under the National Environmental Laboratory Accreditation Program (NELAP), or laboratories that meet International Standardization Organization (ISO 17025) standards or other nationally recognized programs (http://www.epa.gov/fem/accredit.htm) as meeting the Quality System requirements. Respondent shall ensure that all field methodologies utilized in collecting samples for subsequent analysis pursuant to this Settlement are conducted in accordance with the procedures set forth in the QAPP approved by EPA.

e. Upon request, Respondent shall provide split or duplicate samples to EPA and the State or their authorized representatives. Respondent shall notify EPA not less than seven (7) days in advance of any sample collection activity unless shorter notice is agreed to by EPA. In addition, EPA shall have the right to take any additional samples that EPA deems necessary. Upon request, EPA shall provide to Respondent split or duplicate samples of any samples it takes as part of EPA's oversight of Respondents' implementation of the Work.

f. Respondent shall submit to EPA the results of all sampling and/or tests or other data obtained or generated by or on behalf of Respondent with respect to the Site and/or the implementation of this Settlement.

g. Respondent waives any objections to any data gathered, generated, or evaluated by EPA, the State or Respondent in the performance or oversight of the Work that has been verified according to the QA/QC procedures required by the Settlement or any EPA-approved Work Plans, Field Sampling Plans or QAPP addendums. If Respondent objects to any other data relating to the Work, Respondent shall submit to EPA a report that specifically identifies and explains its objections, describes the acceptable uses of the data, if any, and identifies any limitations to the use of the data. The report must be submitted to EPA within fifteen (15) days after the monthly progress report containing the data.

77. Community Involvement Plan. A community involvement plan has been prepared by EPA in accordance with EPA guidance and the NCP. If requested by EPA, Respondent shall participate in community involvement activities, including participation in (1) the preparation of information regarding the Work for dissemination to the public, with consideration given to including mass media and/or Internet notification, and (2) public meetings that may be held or sponsored by EPA to explain activities at or relating to the Site. Respondent's support of EPA's community involvement activities may include providing online access to initial submissions and updates of deliverables to (1) any community advisory groups, (2) any technical assistance grant recipients and their advisors, and (3) other entities to provide them with a reasonable opportunity for review and comment. All community involvement activities conducted by Respondent at EPA's request are subject to EPA's oversight. Upon EPA's request, Respondent shall establish a community information repository at or near the Site to house one copy of the administrative record.

78. Post-Removal Site Control. No later than November 1, 2016, Respondent shall submit a work plan for Post-Removal Site Control which shall include: (1) information on operation of the borehole ventilation system; (2) post-removal monitoring consistent with the routine monitoring program detailed in the Work Plans attached as Appendix C; and (3) methodology for controlling the air flow and TCE concentrations via the existing mitigation systems, which may include the use of various fans, the airlock doors, air polishing units and other ventilation mechanisms (e.g. opening and closing of windows/vent shafts) located throughout the developed portion of the cave. Respondent may also, subject to EPA approval, obtain a written commitment from another party for conduct of such activities. Respondent shall provide EPA with documentation of all Post-Removal Site Control commitments.

79. Progress Reports. Respondent shall submit a written progress report to EPA concerning actions undertaken pursuant to this Settlement on a bi-weekly basis, or as otherwise requested by EPA, from the Effective Date until issuance of Notice of Completion of Work pursuant to Section XXVIII, unless otherwise directed in writing by the RPM. The progress reports may be incorporated into the RI/FS OU2 progress reports. These reports shall describe all significant developments during the preceding period, including the actions performed and any problems encountered, analytical data received during the reporting period, and the developments anticipated during the next reporting period, including a schedule of actions to be performed, anticipated problems, and planned resolutions of past or anticipated problems.

80. Final Report. Within thirty (30) days after completion of all Work required by this Settlement, other than continuing obligations listed in Paragraph 78 and Section XXVIII (Notice of Completion of Work), Respondent shall submit for EPA review and approval a final report summarizing the actions taken to comply with this Settlement. The final report shall conform, at a minimum, with the requirements set forth in Section 300.165 of the NCP entitled "OSC Reports." The final report shall include a good faith estimate of total costs or a statement of actual costs incurred in complying with the Settlement, a listing of quantities and types of materials removed off-Site or handled on-Site, a discussion of removal and disposal options considered for those materials, a listing of the ultimate destinations(s) of those materials, a presentation of the analytical results of all sampling and analyses performed, and accompanying appendices containing all relevant documentation generated during the removal action (e.g., manifests, invoices, bills, contracts, and permits). The final report shall also include the following certification signed by a responsible corporate official of Respondent or Respondent's Project Coordinator: "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I have no personal knowledge that the information submitted is other than true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

81. Off-Site Shipments.

a. Respondent may ship hazardous substances, pollutants and contaminants from the Site to an off-Site facility only if they comply with Section 121(d)(3) of CERCLA, 42 U.S.C. § 9621(d)(3), and 40 C.F.R. § 300.440. Respondent will be deemed to be in compliance with CERCLA Section 121(d)(3) and 40 C.F.R. § 300.440 regarding a shipment if Respondent obtain a prior determination from EPA that the proposed receiving facility for such shipment is acceptable under the criteria of 40 C.F.R. § 300.440(b).

b. Respondent may ship Waste Material from the Site to an out-of-state waste management facility only if, prior to any shipment, it provides written notice to the appropriate state environmental official in the receiving facility's state and to the OSC. This written notice requirement shall not apply to any off-Site shipments when the total quantity of all such shipments will not exceed ten cubic yards. The written notice must include the following information, if available: (1) the name and location of the receiving facility; (2) the type and quantity of Waste Material to be shipped; (3) the schedule for the shipment; and (4) the method of transportation. Respondent also shall notify the state environmental official referenced above and the OSC of any major changes in the shipment plan, such as a decision to ship the Waste Material to a different out-of-state facility. Respondent shall provide the written notice after the award of the contract for the removal action and before the Waste Material is shipped.

c. Respondent may ship Investigation Derived Waste (IDW) from the Site to an off-Site facility only if they comply with Section 121(d)(3) of CERCLA, 42 U.S.C. § 9621(d)(3), 40 C.F.R. § 300.440, EPA's "Guide to Management of Investigation Derived Waste," OSWER 9345.3-03FS (Jan. 1992). Wastes shipped off-Site to a laboratory for characterization, and RCRA hazardous wastes that meet the requirements for an exemption from RCRA under 40 C.F.R. § 261.4(e) shipped off-Site for treatability studies, are not subject to 40 C.F.R. § 300.440.

IX. PROPERTY REQUIREMENTS

82. Agreements Regarding Access and Non-Interference. The EPA understands that MCE is the owner of all real property necessary to complete the work required under the Action Memorandum. Respondent has obtained the cooperation of MCE to implement the Work as described in the Work Plans attached as Appendix C. In the event MCE's cooperation with implementing the Work ceases, EPA will consider issuing a coordinate and cooperate order. The cooperation obtained by Respondent and provided by MCE has provided the EPA, the State, Respondent, and their representatives, contractors, and subcontractors with access at all reasonable times to such Affected Property to conduct any activity regarding the Settlement, including those activities listed in Paragraph 82.a (Access Requirements):

a. Access Requirements. The following is a list of activities for which access is required regarding the Affected Property:

(1) Monitoring the Work;

(2) Verifying any data or information submitted to the United States;

(3) Conducting investigations regarding contamination at or near the Site;

(4) Obtaining samples;

(5) Assessing the need for, planning, implementing, or monitoring response actions;

(6) Assessing implementation of quality assurance and quality control practices as defined in the approved quality assurance quality control plan as defined in the approved QAPP;

(7) Implementing the Work pursuant to the conditions set forth in Paragraph 124 (Work Takeover);

(8) Inspecting and copying records, operating logs, contracts, or other documents maintained or generated by Respondent or their agents, consistent with Section X (Access to Information);

(9) Assessing Respondent's compliance with the Settlement;

(10) Determining whether the Affected Property is being used in a manner that is prohibited or restricted, or that may need to be prohibited or restricted under the Settlement; and

(11) Implementing, monitoring, maintaining, reporting on, and enforcing any land, water, or other resource use restrictions regarding the Affected Property.

b. Land, Water, or Other Resource Use Restrictions. The following is a list of land, water, or other resource use restrictions applicable to the Affected Property:

(1) Respondent shall work with MCE to develop operating procedures for doors, windows and vents to be operated to minimize TCE vapor intrusion into occupied areas of Meramec Caverns and attached buildings; and

(2) Respondent shall assist EPA in working with MCE to develop an environmental covenant that would appropriately limit future use in the cave to minimize exposures to TCE contaminated air, if necessary.

83. If Respondent ever is unable to access the Affected Property, Respondent shall notify EPA, and include a description of the issue creating the access problem and any steps taken to attempt to remedy the problem. If EPA deems it appropriate, it may assist Respondent, or take independent action, in obtaining such access and/or use restrictions. All costs incurred by the United States in providing such assistance or taking such action, including the cost of attorney time and the amount of monetary consideration or just compensation paid, constitute Future Response Costs to be reimbursed under Section XIV (Payment of Response Costs.

84. If EPA determines in a decision document prepared in accordance with the NCP that institutional controls in the form of state or local laws, regulations, ordinances, zoning restrictions, or other governmental controls or notices are needed, Respondent shall cooperate with EPA's and the State's efforts to secure and ensure compliance with such institutional controls.

85. In the event of any Transfer of the Affected Property, unless EPA otherwise consents in writing, Respondent shall continue to comply with its obligations under the Settlement, including Respondent's obligation to secure access, unless the then-current owner elects to discontinue offering tours of Meramec Caverns to the public.

X. ACCESS TO INFORMATION

86. Respondent shall provide to EPA and the State, upon request, copies of all records, reports, documents, and other information (including records, reports, documents, and

other information in electronic form) (hereinafter referred to as "Records") within Respondent's possession or control or that of its contractors or agents relating to activities at the Site or to the implementation of this Settlement, including, but not limited to, sampling, analysis, chain of custody records, manifests, trucking logs, receipts, reports, sample traffic routing, correspondence, or other documents or information regarding the Work. Respondent shall also make available to EPA and the State, for purposes of investigation, information gathering, or testimony, their employees, agents, or representatives with knowledge of relevant facts concerning the performance of the Work.

87. Privileged and Protected Claims.

a. Respondent may assert all or part of a Record requested by EPA or the State is privileged or protected as provided under federal law, in lieu of providing the Record, provided Respondent complies with the following subparagraph b, and except as provided in subparagraph c.

b. If Respondent asserts such a privilege or protection, it shall provide EPA and the State with the following information regarding such Record: its title; its date; the name, title, affiliation (e.g., company or firm), and address of the author, of each addressee, and of each recipient; a description of the Record's contents; and the privilege or protection asserted. If a claim of privilege or protection applies only to a portion of a Record, Respondent shall provide the Record to EPA and the State in redacted form to mask the privileged or protected portion only. Respondent shall retain all Records that they claim to be privileged or protected until EPA and the State have had a reasonable opportunity to dispute the privilege or protection claim and any such dispute has been resolved in Respondents' favor.

c. Respondent may make no claim of privilege or protection regarding: (1) any data regarding the Site, including, but not limited to, all sampling, analytical, monitoring, hydrogeologic, scientific, chemical, radiological, or engineering data, or the portion of any other Record that evidences conditions at or around the Site; or (2) the portion of any Record that Respondent is required to create or generate pursuant to this Settlement.

88. Business Confidential Claims. Respondent may assert that all or part of a Record provided to EPA and the State under this Section or Section XI (Record Retention) is business confidential to the extent permitted by and in accordance with Section 104(e)(7) of CERCLA, 42 U.S.C. § 9604(e)(7), and 40 C.F.R. § 2.203(b). Respondent shall segregate and clearly identify all Records or parts thereof submitted under this Settlement for which Respondent asserts business confidentiality claims. Records submitted to EPA determined to be confidential by EPA will be afforded the protection specified in 40 C.F.R. Part 2, Subpart B. If no claim of confidentiality accompanies Records when they are submitted to EPA and the State, or if EPA has notified Respondent that the Records are not confidential under the standards of Section 104(e)(7) of CERCLA or 40 C.F.R. Part 2, Subpart B, the public may be given access to such Records without further notice to Respondent.

89. Notwithstanding any provision of this Settlement, EPA and the State retain all of their information gathering and inspection authorities and rights, including enforcement actions related thereto, under CERCLA, RCRA, and any other applicable statutes or regulations.

XI. RECORD RETENTION

90. Until ten (10) years after EPA provides Respondent with notice, pursuant to Section XXVIII (Notice of Completion of Work), that all Work has been fully performed in accordance with this Settlement, Respondent shall preserve and retain all non-identical copies of Records (including Records in electronic form) now in its possession or control, or that come into its possession or control, that relate in any manner to its liability under CERCLA with regard to the Site. Respondent must also retain, and instruct its contractors and agents to preserve, for the same period of time specified above all non-identical copies of the last draft or final version of any Records (including Records in electronic form) now in its possession or control or that come into Respondent's possession or control that relate in any manner to the performance of the Work, provided, however, that Respondent (and its contractors and agents) must retain, in addition, copies of all data generated during the performance of the Work and not contained in the aforementioned Records required to be retained. Each of the above record retention requirements shall apply regardless of any corporate retention policy to the contrary.

91. At the conclusion of the document retention period, Respondent shall notify EPA at least ninety (90) days prior to the destruction of any such Records, and, upon request by EPA, and except as provided in Paragraph 87 (Privileged and Protected Claims), Respondent shall deliver any such Records to EPA.

92. Respondent certifies that, to the best of its knowledge and belief, after thorough inquiry, it has not altered, mutilated, discarded, destroyed, or otherwise disposed of any Records (other than identical copies) relating to its potential liability regarding the Site since notification of potential liability by EPA or the State and that it has fully complied with any and all EPA and State requests for information regarding the Site pursuant to Sections 104(e) and 122(e) of CERCLA, 42 U.S.C. §§ 9604(e) and 9622(e), and Section 3007 of RCRA, 42 U.S.C. § 6927, and state law.

XII. COMPLIANCE WITH OTHER LAWS

93. Nothing in this Settlement limits Respondent's obligations to comply with the requirements of all applicable state and federal laws and regulations, except as provided in Section 121(e) of CERCLA, 42 U.S.C. § 6921(e), and 40 C.F.R. §§ 300.400(e) and 300.415(j). In accordance with 40 C.F.R. § 300.415(j), all on-site actions required pursuant to this Settlement shall, to the extent practicable, as determined by EPA, considering the exigencies of the situation, attain applicable or relevant and appropriate requirements ("ARARs") under federal environmental or state environmental or facility siting laws. ARARs were previously developed by Respondent in the Work Plan for Remedial Investigation and Feasibility Study dated February 12, 2010, which have been approved by EPA. If additional ARARs are identified they will be outlined in the Action Memorandum.

94. No local, state, or federal permit shall be required for any portion of the Work conducted entirely on-site (i.e., within the areal extent of contamination or in very close proximity to the contamination and necessary for implementation of the Work), including studies, if the action is selected and carried out in compliance with Section 121 of CERCLA, 42 U.S.C. § 9621. Where any portion of the Work that is not on-site requires a federal or state permit or approval, Respondent shall submit timely and complete applications and take all other actions necessary to obtain and to comply with all such permits or approvals. performance of the Work resulting from a failure to obtain, or a delay in obtaining, any permit or approval required for the Work, provided that they have submitted timely and complete applications and taken all other actions necessary to obtain all such permits or approvals. This Settlement is not, and shall not be construed to be, a permit issued pursuant to any federal or state statute or regulation.

XIII. EMERGENCY RESPONSE AND NOTIFICATION OF RELEASES

95. Emergency Response. If any event occurs during performance of the Work that causes or threatens to cause a release of Waste Material on, at, or from the Site that either constitutes an emergency situation or that may present an immediate threat to public health or welfare or the environment, Respondent shall immediately take all appropriate action to prevent, abate, or minimize such release or threat of release. Respondent shall take these actions in accordance with all applicable provisions of this Settlement, including, but not limited to, the Health and Safety Plan. Respondent shall also immediately notify the RPM or, in the event of his/her unavailability, the Regional Duty Officer at (913) 281-0991 of the incident or Site conditions. In the event that Respondent fails to take appropriate response action as required by this Paragraph, and EPA takes such action instead, Respondent shall reimburse EPA for all costs of such response action not inconsistent with the NCP pursuant to Section XIV (Payment of Response Costs).

96. Release Reporting. Upon the occurrence of any event during performance of the Work that Respondent is required to report pursuant to Section 103 of CERCLA, 42 U.S.C. § 9603, or Section 304 of the Emergency Planning and Community Right-to-know Act (EPCRA), 42 U.S.C. § 11004, Respondent shall immediately orally notify the RPM or OSC, in the event of his/her unavailability, the Regional Duty Officer at (913) 281-0991, and the National Response Center at (800) 424-8802. This reporting requirement is in addition to, and not in lieu of, reporting under Section 103(c) of CERCLA, 42 U.S.C. § 9603(c), and Section 304 of the Emergency Planning and Community Right-To-Know Act of 1986, 42 U.S.C. § 11004.

97. For any event covered under this Section, Respondent shall submit a written report to EPA within seven (7) days after the onset of such event, setting forth the action or event that occurred and the measures taken, and to be taken, to mitigate any release or threat of release or endangerment caused or threatened by the release and to prevent the reoccurrence of such a release or threat of release.

XIV. PAYMENT OF RESPONSE COSTS

98. Payments for Future Response Costs. Respondent shall pay to EPA all Future Response Costs not inconsistent with the NCP.

a. Respondent shall make payment to EPA by Fedwire Electronic Funds Transfer (EFT) to:

Federal Reserve Bank of New York
ABA = 021030004
Account = 68010727
SWIFT address = FRNYUS33
33 Liberty Street
New York, NY 10045
Field Tag 4200 of the Fedwire message should read "D 68010727 Environmental Protection Agency"

and shall reference Site/Spill ID Number 07PZ and the EPA docket number for this action.

b. Periodic Bills. On a periodic basis, EPA will send Respondent a bill requiring payment that includes a Regionally-prepared cost summary, which includes direct and indirect costs incurred by EPA, its contractors, subcontractors, and the United States Department of Justice. Respondent shall make all payments within thirty (30) days after Respondent's receipt of each bill requiring payment, except as otherwise provided in Paragraph 97 (Contesting Future Response Costs).

c. Deposit of Future Response Costs Payments. The total amount to be paid by Respondent pursuant to Paragraph 98.b (Periodic Bills) shall be deposited by EPA in the Special Account to be retained and used to conduct or finance response actions at or in connection with the Site, or to be transferred by EPA to the EPA Hazardous Substance Superfund, provided, however, that EPA may deposit a Future Response Costs payment directly into the EPA Hazardous Substance Superfund if, at the time the payment is received, EPA estimates that the Special Account balance is sufficient to address currently anticipated future response actions to be conducted or financed by EPA at or in connection with the Site. Any decision by EPA to deposit a Future Response Costs payment directly into the EPA Hazardous Substance Superfund for this reason shall not be subject to challenge by Respondent pursuant to the dispute resolution provisions of this Settlement or in any other forum.

99. Interest. In the event that any payment for Future Response Costs is not made by the date required, Respondent shall pay Interest on the unpaid balance. The Interest on Future Response Costs shall begin to accrue on the date of the bill. The Interest shall accrue through the date of Respondent's payment. Payments of Interest made under this Paragraph shall be in addition to such other remedies or sanctions available to the United States by virtue of Respondent's failure to make timely payments under this Section, including but not limited to, payment of stipulated penalties pursuant to Paragraph 111 (Stipulated Penalties - Work).

100. Contesting Future Response Costs. Respondent may initiate the procedures of Section XV (Dispute Resolution) regarding payment of any Future Response Costs billed under Paragraph 98.b (Payments for Future Response Costs) if Respondent determines that EPA has made a mathematical error or included a cost item that is not within the definition of Future Response Costs, or if it believes EPA incurred excess costs as a direct result of an EPA action that was inconsistent with a specific provision or provisions of the NCP. To initiate such dispute, Respondent shall submit a Notice of Dispute in writing to the RPM within thirty (30) days after receipt of the bill. Any such Notice of Dispute shall specifically identify the contested Future Response Costs and the basis for objection. If Respondent submits a Notice of Dispute, Respondent shall within the 30-day period, also as a requirement for initiating the dispute, (a) pay all uncontested Future Response Costs to EPA in the manner described in Paragraph 98.a, and (b) establish, in a duly chartered bank or trust company, an interest-bearing escrow account that is insured by the Federal Deposit Insurance Corporation (FDIC) and remit to that escrow account funds equivalent to the amount of the contested Future Response Costs. Respondent shall send to the RPM a copy of the transmittal letter and check paying the uncontested Future Response Costs, and a copy of the correspondence that establishes and funds the escrow account, including, but not limited to, information containing the identity of the bank and bank account under which the escrow account is established as well as a bank statement showing the initial balance of the escrow account. If EPA prevails in the dispute, within five (5) days after the resolution of the dispute, Respondent shall pay the sums due (with accrued interest) to EPA in the manner described in Paragraph 98.a. If Respondent prevails concerning any aspect of the contested costs, Respondent shall pay that portion of the costs (plus associated accrued interest) for which they did not prevail to EPA in the manner described in Paragraph 98.a. Respondent shall be disbursed any balance of the escrow account. The dispute resolution procedures set forth in this Paragraph in conjunction with the procedures set forth in Section XV (Dispute Resolution) shall be the exclusive mechanisms for resolving disputes regarding Respondents' obligation to reimburse EPA for its Future Response Costs.

XV. DISPUTE RESOLUTION

101. Unless otherwise expressly provided for in this Settlement, the dispute resolution procedures of this Section shall be the exclusive mechanism for resolving disputes arising under this Settlement. The Parties shall attempt to resolve any disagreements concerning this Settlement expeditiously and informally.

102. Informal Dispute Resolution. If Respondent objects to any EPA action taken pursuant to this Settlement, including billings for Future Response Costs, Respondent shall send EPA a written Notice of Dispute describing the objection(s) within fifteen (15) days after such action. EPA and Respondent shall have ten (10) days from EPA's receipt of Respondent's Notice of Dispute to resolve the dispute through informal negotiations (the "Negotiation Period"). The Negotiation Period may be extended at the sole discretion of EPA. Any agreement reached by the Parties pursuant to this Section shall be in writing and shall, upon signature by the Parties, be incorporated into and become an enforceable part of this Settlement.

103. Formal Dispute Resolution. If the Parties are unable to reach an agreement within the Negotiation Period, Respondent shall, within twenty (20) days after the end of the

Negotiation Period, submit a statement of position to the RPM. EPA may, within twenty (20) days thereafter, submit a statement of position. Thereafter, an EPA Region 7 management official at the Division Director level or higher will issue a written decision on the dispute to Respondent. EPA's decision shall be incorporated into and become an enforceable part of this Settlement. Respondent shall fulfill the requirement that was the subject of the dispute in accordance with the agreement reached or with EPA's decision, whichever occurs.

104. Except as provided in Paragraph 100 (Contesting Future Response Costs) or as agreed by EPA, the invocation of formal dispute resolution procedures under this Section does not extend, postpone, or affect in any way any obligation of Respondent under this Settlement. Except as provided in Paragraph 114, stipulated penalties with respect to the disputed matter shall continue to accrue, but payment shall be stayed pending resolution of the dispute. Notwithstanding the stay of payment, stipulated penalties shall accrue from the first day of noncompliance with any applicable provision of this Settlement. In the event that Respondent does not prevail on the disputed issue, stipulated penalties shall be assessed and paid as provided in Section XVII (Stipulated Penalties).

XVI. FORCE MAJEURE

105. "Force Majeure" for purposes of this Settlement, is defined as any event arising from causes beyond the control of Respondent, of any entity controlled by Respondent, or of Respondent's contractors that delays or prevents the performance of any obligation under this Settlement despite Respondent's best efforts to fulfill the obligation. The requirement that Respondent exercise "best efforts to fulfill the obligation" includes using best efforts to anticipate any potential force majeure and best efforts to address the effects of any potential force majeure (a) as it is occurring and (b) following the potential force majeure such that the delay and any adverse effects of the delay are minimized to the greatest extent possible. "Force majeure" does not include financial inability to complete the Work or increased cost of performance or a failure of the Work required under this Settlement to attain performance standards set forth in the Action Memorandum.

106. If any event occurs or has occurred that may delay the performance of any obligation under this Settlement for which Respondent intends or may intend to assert a claim of force majeure, Respondent shall notify EPA's RPM orally or, in his or her absence, the RPMs' Supervising Manager, or, in the event both of EPA's designated representatives are unavailable, the Director of the Superfund Division, EPA Region 7, within five (5) days of when Respondent first knew that the event might cause a delay. Within five (5) days thereafter, Respondent shall provide in writing to EPA an explanation and description of the reasons for the delay; the anticipated duration of the delay; all actions taken or to be taken to prevent or minimize the delay; a schedule for implementation of any measures to be taken to prevent or mitigate the delay or the effect of the delay; Respondent's rationale for attributing such delay to a force majeure; and a statement as to whether, in the opinion of Respondent, such event may cause or contribute to an endangerment to public health or welfare, or the environment. Respondent shall include with any notice all available documentation supporting the claim that the delay was attributable to a force majeure. Respondent shall be deemed to know of any circumstance of which Respondent, any entity controlled by Respondent, or Respondent's contractors knew or should

have known. Failure to comply with the above requirements regarding an event shall preclude Respondent from asserting any claim of force majeure regarding that event, provided, however, that if EPA, despite the late or incomplete notice, is able to assess to its satisfaction whether the event is a force majeure under Paragraph 105 and whether Respondent has exercised best efforts under Paragraph 105, EPA may, in its unreviewable discretion, excuse in writing Respondent's failure to submit timely or complete notices under this Paragraph.

107. If EPA agrees that the delay or anticipated delay is attributable to a force majeure, the time for performance of the obligations under this Settlement that are affected by the force majeure will be extended by EPA for such time as is necessary to complete those obligations. An extension of the time for performance of the obligations affected by the force majeure shall not, of itself, extend the time for performance of any other obligation. If EPA does not agree that the delay or anticipated delay has been or will be caused by a force majeure, EPA will notify Respondent in writing of its decision. If EPA agrees that the delay is attributable to a force majeure, EPA will notify Respondent in writing of the length of the extension, if any, for performance of the obligations affected by the force majeure.

108. If Respondent elects to invoke the dispute resolution procedures set forth in Section XV (Dispute Resolution), it shall do so no later than fifteen (15) days after receipt of EPA's notice. In any such proceeding, Respondent shall have the burden of demonstrating by a preponderance of the evidence that the delay or anticipated delay has been or will be caused by a force majeure, that the duration of the delay or the extension sought was or will be warranted under the circumstances, that best efforts were exercised to avoid and mitigate the effects of the delay, and that Respondent complied with the requirements of Paragraphs 105 and 106. If Respondent carries this burden, the delay at issue shall be deemed not to be a violation by Respondent of the affected obligation of this Settlement identified to EPA.

109. The failure by EPA to timely complete any obligation under the Settlement is not a violation of the Settlement, provided, however, that if such failure prevents Respondent from meeting one or more deadlines under the Settlement, Respondent may seek relief under this Section.

XVII. STIPULATED PENALTIES

110. Respondent shall be liable to EPA for stipulated penalties in the amounts set forth in Paragraphs 111 and 112 for failure to comply with the requirements of this Settlement specified below, unless excused under Section XVI (Force Majeure). "Compliance" by Respondent shall include completion of all activities and obligations, including payments, required under this Settlement, or any deliverable approved under this Settlement, in accordance with all applicable requirements of law, this Settlement, the attached Action Memo, and any deliverables approved under this Settlement and within the specified time schedules established by and approved under this Settlement.

111. Stipulated Penalty Amounts - Work (Including Payments and Excluding Deliverables).

a. The following stipulated penalties shall accrue per violation per day for any noncompliance identified in Paragraph 111.b:

Penalty Per Violation Per Day	Period of Noncompliance
$ 500.00	1st through 14th day
$ 1,000.00	15th through 30th day
$ 1,500.00	31st day and beyond

b. Compliance Milestones. Establishment and maintenance of financial assurance in compliance with the timelines and other substantive and procedural requirements of Section XXV (Financial Assurance) and completion of the Work contained in the Work Plans attached as Appendix C according to the approved Work schedule.

112. Stipulated Penalty Amounts - Deliverables. The following stipulated penalties shall accrue per violation per day for failure to submit timely or adequate deliverables pursuant to this Settlement:

Penalty Per Violation Per Day	Period of Noncompliance
$ 250.00	1st through 14th day
$ 500.00	15th through 30th day
$ 1,000.00	31st day and beyond

113. In the event that EPA assumes performance of a portion or all of the Work pursuant to Paragraph 124 (Work Takeover), Respondent shall be liable for a stipulated penalty in the amount of $ 50,000.00. "Stipulated penalties under this Paragraph are in addition to the remedies available to EPA under Paragraphs 124 (Work Takeover) and 145.b (Access to Financial Assurance).

114. All penalties shall begin to accrue on the day after the complete performance is due or the day a violation occurs and shall continue to accrue through the final day of the correction of the noncompliance or completion of the activity. Penalties shall continue to accrue during any dispute resolution period, and shall be paid within fifteen (15) days after the agreement or the receipt of EPA's decision or order. However, stipulated penalties shall not accrue: (a) with respect to a deficient submission under Paragraph 73 (Work Plan and Implementation), during the period, if any, beginning on the 31st day after EPA's receipt of such submission until the date that EPA notifies Respondent of any deficiency; and (b) with respect to a decision by the EPA Region 7 Management Official at the Division Director level or higher, under Paragraph 103 (Formal Dispute Resolution), during the period, if any, beginning on the 21st day after the Negotiation Period begins until the date that the EPA Management Official issues a final decision regarding such dispute. Nothing in this Settlement shall prevent the simultaneous accrual of separate penalties for separate violations of this Settlement.

115. Following EPA's determination that Respondent has failed to comply with a requirement of this Settlement, EPA may give Respondent written notification of the failure and describe the noncompliance. EPA may send Respondent a written demand for payment of the penalties. However, penalties shall accrue as provided in the preceding Paragraph regardless of whether EPA has notified Respondent of a violation.

116. All penalties accruing under this Section shall be due and payable to EPA within thirty (30) days after Respondent's receipt from EPA of a demand for payment of the penalties, unless Respondent invokes the Dispute Resolution procedures under Section XV (Dispute Resolution) within the 30-day payment period. All payments to EPA under this Section shall indicate that the payment is for stipulated penalties and shall be made in accordance with Paragraph 98.b (Payments for Future Response Costs).

117. If Respondent fails to pay stipulated penalties when due, Respondent shall pay Interest on the unpaid stipulated penalties as follows: (a) if Respondent has timely invoked dispute resolution such that the obligation to pay stipulated penalties has been stayed pending the outcome of dispute resolution, Interest shall accrue from the date stipulated penalties are due pursuant to Paragraph 114 until the date of payment; and (b) if Respondent fails to timely invoke dispute resolution, Interest shall accrue from the date of demand under Paragraph 116 until the date of payment. If Respondent fails to pay stipulated penalties and Interest when due, the United States may institute proceedings to collect the penalties and Interest.

118. The payment of penalties and Interest, if any, shall not alter in any way Respondent's obligation to complete the performance of the Work required under this Settlement.

119. Nothing in this Settlement shall be construed as prohibiting, altering, or in any way limiting the ability of EPA to seek any other remedies or sanctions available by virtue of Respondent's violation of this Settlement or of the statutes and regulations upon which it is based, including, but not limited to, penalties pursuant to Sections 106(b) and 122(*l*) of CERCLA, 42 U.S.C. §§ 9606(b) and 9622(*l*), and punitive damages pursuant to Section 107(c)(3) of CERCLA, 42 U.S.C. § 9607(c)(3), provided however, that EPA shall not seek civil penalties pursuant to Section 106(b) or Section 122(*l*) of CERCLA or punitive damages pursuant to Section 107(c)(3) of CERCLA for any violation for which a stipulated penalty is provided in this Settlement, except in the case of a willful violation of this Settlement or in the event that EPA assumes performance of a portion or all of the Work pursuant to Paragraph 124 (Work Takeover).

120. Notwithstanding any other provision of this Section, EPA may, in its unreviewable discretion, waive any portion of stipulated penalties that have accrued pursuant to this Settlement.

XVIII. COVENANTS BY EPA

121. Except as provided in Section XIX (Reservations of Rights by EPA), EPA covenants not to sue or to take administrative action against Respondent pursuant to Sections 106

and 107(a) of CERCLA, 42 U.S.C. §§ 9606 and 9607(a), for the Work and Future Response Costs. These covenants shall take effect upon the Effective Date. These covenants are conditioned upon the complete and satisfactory performance by Respondent of its obligations under this Settlement. These covenants extend only to Respondent and do not extend to any other person.

XIX. RESERVATIONS OF RIGHTS BY EPA

122. Except as specifically provided in this Settlement, nothing in this Settlement shall limit the power and authority of EPA or the United States to take, direct, or order all actions necessary to protect public health, welfare, or the environment or to prevent, abate, or minimize an actual or threatened release of hazardous substances, pollutants, or contaminants, or hazardous or solid waste on, at, or from the Site. Further, nothing in this Settlement shall prevent EPA from seeking legal or equitable relief to enforce the terms of this Settlement, from taking other legal or equitable action as it deems appropriate and necessary, or from requiring Respondent in the future to perform additional activities pursuant to CERCLA or any other applicable law.

123. The covenants set forth in Section XVIII (Covenants by EPA) do not pertain to any matters other than those expressly identified therein. EPA reserves, and this Settlement is without prejudice to, all rights against Respondent with respect to all other matters, including, but not limited to:

a. liability for failure by Respondent to meet a requirement of this Settlement;

b. liability for costs not included within the definition of Future Response Costs;

c. liability for performance of response action other than the Work;

d. criminal liability;

e. liability for violations of federal or state law that occur during or after implementation of the Work;

f. liability for damages for injury to, destruction of, or loss of natural resources, and for the costs of any natural resource damage assessments;

g. liability arising from the past, present, or future disposal, release or threat of release of Waste Materials outside of the Site; and

h. liability for costs incurred or to be incurred by the Agency for Toxic Substances and Disease Registry related to the Site not paid as Future Response Costs under this Settlement.

124. Work Takeover.

a. In the event EPA determines that Respondent: (1) has ceased implementation of any portion of the Work; (2) is seriously or repeatedly deficient or late in performance of the Work; or (3) is implementing the Work in a manner that may cause an endangerment to human health or the environment, EPA may issue a written notice (Work Takeover Notice) to Respondent. Any Work Takeover Notice issued by EPA (which writing may be electronic) will specify the grounds upon which such notice was issued and will provide Respondent a period of three (3) days within which to fully remedy the circumstances giving rise to EPA's issuance of such notice.

b. If, after expiration of the 3-day notice period specified in Paragraph 124, Respondent has not remedied to EPA's satisfaction the circumstances giving rise to EPA's issuance of the relevant Work Takeover Notice, EPA may at any time thereafter assume the performance of all or any portion(s) of the Work as EPA deems necessary (Work Takeover). EPA will notify Respondent in writing (which writing may be electronic) if EPA determines that implementation of a Work Takeover is warranted under this Paragraph 124.b. Funding of Work Takeover costs is addressed under Paragraph 145 (Access to Financial Assurance).

c. Respondent may invoke the procedures set forth in Paragraph 103 (Formal Dispute Resolution) to dispute EPA's implementation of a Work Takeover under Paragraph 124. However, notwithstanding Respondent's invocation of such dispute resolution procedures, and during the pendency of any such dispute, EPA may in its sole discretion commence and continue a Work Takeover under Paragraph 124.b until the earlier of either; (1) the date that Respondent remedies, to EPA's satisfaction, the circumstances giving rise to EPA's issuance of the relevant Work Takeover Notice; or (2) the date that a written decision terminating such Work Takeover is rendered in accordance with Paragraph 103 (Formal Dispute Resolution).

d. Notwithstanding any other provision of this Settlement, EPA retains all authority and reserves all rights to take any and all response actions authorized by law.

XX. COVENANTS BY RESPONDENT

125. Respondent covenants not to sue and agrees not to assert any claims or causes of action against the United States, or its contractors or employees, with respect to the Work, Future Response Costs, and this Settlement, including, but not limited to:

a. any direct or indirect claim for reimbursement from the EPA Hazardous Substance Superfund through Sections 106(b)(2), 107, 111, 112, or 113 of CERCLA, 42 U.S.C. §§ 9606(b)(2), 9607, 9611, 9612, or 9613, or any other provision of law;

b. any claims under Sections 107 and 113 of CERCLA, Section 7002(a) of RCRA, 42 U.S.C. § 6972(a), or state law regarding the Work, Future Response Costs, and this Settlement; or

c. any claim arising out of response actions at or in connection with the Site, including any claim under the United States Constitution, the Missouri Constitution, the Tucker Act, 28 U.S.C. § 1491, the Equal Access to Justice Act, 28 U.S.C. § 2412, or at common law.

126. Except as provided in Paragraph 129 (Waiver of Claims by Respondent), these covenants not to sue shall not apply in the event the United States brings a cause of action or issues an order pursuant to any of the reservations set forth in Section XIX (Reservations of Rights by EPA), other than in Paragraphs 123.a (liability for failure to meet a requirement of the Settlement), 123.d (criminal liability), or 123.e (violations of federal/state law during or after implementation of the Work), but only to the extent that Respondent's claims arise from the same response action, response costs, or damages that the United States is seeking pursuant to the applicable reservation.

127. Nothing in this Settlement shall be deemed to constitute approval or preauthorization of a claim within the meaning of Section 111 of CERCLA, 42 U.S.C. § 9611, or 40 C.F.R. § 300.700(d).

128. Respondent reserves, and this Settlement is without prejudice to, claims against the United States, subject to the provisions of Chapter 171 of Title 28 of the United States Code, and brought pursuant to any statute other than CERCLA or RCRA and for which the waiver of sovereign immunity is found in a statute other than CERCLA or RCRA, for money damages for injury or loss of property or personal injury or death caused by the negligent or wrongful act or omission of any employee of the United States, as that term is defined in 28 U.S.C. § 2671, while acting within the scope of his or her office or employment under circumstances where the United States, if a private person, would be liable to the claimant in accordance with the law of the place where the act or omission occurred. However, the foregoing shall not include any claim based on EPA's selection of response actions, or the oversight or approval of Respondent's deliverables or activities.

129. Waiver of Claims by Respondent.

a. Respondent agrees not to assert any claims and to waive all claims or causes of action (including but not limited to claims or causes of action under Sections 107(a) and 113 of CERCLA) that they may have:

i. De Micromis Waiver. For all matters relating to the Site against any person where the person's liability to Respondent with respect to the Site is based solely on having arranged for disposal or treatment, or for transport for disposal or treatment, of hazardous substances at the Site, or having accepted for transport for disposal or treatment of hazardous substances at the Site, if all or part of the disposal, treatment, or transport

occurred before April 1, 2001, and the total amount of material containing hazardous substances contributed by such person to the Site was less than 110 gallons of liquid materials or 200 pounds of solid materials.

b. Exceptions to Waivers.

i. The waivers under this Paragraph 129 shall not apply with respect to any defense, claim, or cause of action that Respondent may have against any person otherwise covered by such waivers if such person asserts a claim or cause of action relating to the Site against Respondent.

ii. The waiver under Paragraph 129.a.i (De Micromis Waiver) shall not apply to any claim or cause of action against any person otherwise covered by such waiver if EPA determines that: (i) the materials containing hazardous substances contributed to the Site by such person contributed significantly or could contribute significantly, either individually or in the aggregate, to the cost of the response action or natural resource restoration at the Site; or (ii) such person has failed to comply with any information request or administrative subpoena issued pursuant to Section 104(e) or 122(e) of CERCLA, 42 U.S.C. § 9604(e) or 9622(e), or Section 3007 of RCRA, 42 U.S.C. § 6927, or has impeded or is impeding, through action or inaction, the performance of a response action or natural resource restoration with respect to the Site; or if (iii) such person has been convicted of a criminal violation for the conduct to which the waiver would apply and that conviction has not been vitiated on appeal or otherwise.

XXI. OTHER CLAIMS

130. By issuance of this Settlement, the United States and EPA assume no liability for injuries or damages to persons or property resulting from any acts or omissions of Respondent. The United States or EPA shall not be deemed a party to any contract entered into by Respondent or its members, officers, employees, agents, successors, representatives, assigns, contractors, or consultants in carrying out actions pursuant to this Settlement.

131. Except as expressly provided in Paragraphs 129 (Waiver of Claims by Respondent) and Section XVIII (Covenants by EPA), nothing in this Settlement constitutes a satisfaction of or release from any claim or cause of action against Respondent or any person not a party to this Settlement, for any liability such person may have under CERCLA, other statutes, or common law, including but not limited to any claims of the United States for costs, damages, and interest under Sections 106 and 107 of CERCLA, 42 U.S.C. §§ 9606 and 9607.

132. No action or decision by EPA pursuant to this Settlement shall give rise to any right to judicial review, except as set forth in Section 113(h) of CERCLA, 42 U.S.C. § 9613(h).

XXII. EFFECT OF SETTLEMENT/CONTRIBUTION

133. Except as provided in Paragraph 129 (Waiver of Claims by Respondent), nothing in this Settlement shall be construed to create any rights in, or grant any cause of action to, any person not a Party to this Settlement. Except as provided in Section XX (Covenants by Respondent), the Parties expressly reserves any and all rights (including, but not limited to, pursuant to Section 113 of CERCLA, 42 U.S.C. § 9613), defenses, claims, demands, and causes of action which each Party may have with respect to any matter, transaction, or occurrence relating in any way to the Site against any person not a Party hereto. Nothing in this Settlement diminishes the right of the United States, pursuant to Section 113(f)(2) and (3) of CERCLA, 42 U.S.C. § 9613(f)(2)-(3), to pursue any such persons to obtain additional response costs or response action and to enter into settlements that give rise to contribution protection pursuant to Section 113(f)(2).

134. The Parties agree that this Settlement constitutes an administrative settlement pursuant to which Respondent has, as of the Effective Date, resolved liability to the United States within the meaning of Sections 113(f)(2) and 122(h)(4) of CERCLA, 42 U.S.C. §§ 9613(f)(2) and 9622(h)(4), and is entitled, as of the Effective Date, to protection from contribution actions or claims as provided by Sections 113(f)(2) and 122(h)(4) of CERCLA, or as may be otherwise provided by law, for the "matters addressed" in this Settlement. The "matters addressed" in this Settlement are the Work and Future Response Costs.

135. The Parties further agree that this Settlement constitutes an administrative settlement pursuant to which Respondent has, as of the Effective Date, resolved liability to the United States within the meaning of Section 113(f)(3)(B) of CERCLA, 42 U.S.C. § 9613(f)(3)(B).

136. Respondent shall, with respect to any suit or claim brought by it for matters related to this Settlement, notify EPA in writing no later than sixty (60) days prior to the initiation of such suit or claim. Respondent also shall, with respect to any suit or claim brought against it for matters related to this Settlement, notify EPA in writing within ten (10) days after service of the complaint or claim upon it. In addition, Respondent shall notify EPA within ten (10) days after service or receipt of any Motion for Summary Judgment and within ten (10) days after receipt of any order from a court setting a case for trial, for matters related to this Settlement.

137. In any subsequent administrative or judicial proceeding initiated by EPA, or by the United States on behalf of EPA, for injunctive relief, recovery of response costs, or other relief relating to the Site, Respondent shall not assert, and may not maintain, any defense or claim based upon the principles of waiver, res judicata, collateral estoppel, issue preclusion, claim-splitting, or other defenses based upon any contention that the claims raised in the subsequent proceeding were or should have been brought in the instant case; provided, however, that nothing in this Paragraph affects the enforceability of the covenant by EPA set forth in Section XVIII (Covenants by EPA).

XXIII. INDEMNIFICATION

138. The United States does not assume any liability by entering into this Settlement or by virtue of any designation of Respondent as EPA's authorized representatives under Section 104(e) of CERCLA, 42 U.S.C. § 9604(e), and 40 C.F.R. 300.400(d)(3). Respondent shall indemnify, save, and hold harmless the United States, its officials, agents, employees, contractors, subcontractors, and representatives for or from any and all claims or causes of action arising from, or on account of, negligent or other wrongful acts or omissions of Respondent, its members, officers, directors, employees, agents, contractors, or subcontractors, and any persons acting on Respondents' behalf or under their control, in carrying out activities pursuant to this Settlement. Further, Respondent agrees to pay the United States all costs it incurs, including but not limited to attorneys' fees and other expenses of litigation and settlement arising from, or on account of, claims made against the United States based on negligent or other wrongful acts or omissions of Respondent, its members, officers, directors, employees, agents, contractors, subcontractors, and any persons acting on their behalf or under their control, in carrying out activities pursuant to this Settlement. The United States shall not be held out as a party to any contract entered into by or on behalf of Respondent in carrying out activities pursuant to this Settlement. Neither the Respondent nor any such contractor or subcontrator shall be considered an agent of the United States.

139. The United States shall give Respondent notice of any claim for which the United States plans to seek indemnification pursuant to this Section and shall consult with Respondent prior to settling such claim.

140. Respondent covenants not to sue and agrees not to assert any claims or causes of action against the United States for damages or reimbursement or for set-off of any payments made or to be made to the United States, arising from or on account of any contract, agreement, or arrangement between Respondent and any person for performance of Work on or relating to the Site, including, but not limited to, claims on account of construction delays. In addition, Respondent shall indemnify and hold harmless the United States with respect to any and all claims for damages or reimbursement arising from or on account of any contract, agreement, or arrangement between Respondent and any person for performance of Work on or relating to the Site, including, but not limited to, claims on account of construction delays.

XXIV. INSURANCE

141. Respondent has secured, and shall maintain until the first anniversary after issuance of Notice of Completion of Work pursuant to Section XXVIII (Notice of Completion of Work), a commercial general liability insurance with limits of $ 1 million, for any one occurrence, and automobile insurance with limits of $ 1 million, combined single limit, naming EPA as an additional insured with respect to all liability arising out of the activities performed by or on behalf of Respondent pursuant to this Settlement. In addition, for the duration of the Settlement, Respondent shall provide EPA with certificates of such insurance and a copy of each insurance policy. Respondent shall resubmit such certificates and copies of policies each year on the anniversary of the Effective Date. In addition, for the duration of the Settlement, Respondent shall satisfy, or shall ensure that their contractors or subcontractors satisfy, all applicable laws

and regulations regarding the provision of worker's compensation insurance for all persons performing the Work on behalf of Respondent in furtherance of this Settlement. If Respondent demonstrates by evidence satisfactory to EPA that any contractor or subcontractor maintains insurance equivalent to that described above, or insurance covering some or all of the same risks but in a lesser amount, Respondent need provide only that portion of the insurance described above that is not maintained by the contractor or subcontractor.

XV. FINANCIAL ASSURANCE

142. In order to ensure completion of the Work, Respondent has secured financial assurance, initially in the amount of $700,000, for the benefit of EPA for the RI/FS OU2 work, which amount shall also be considered financial assurance for the Work under this Settlement. The financial assurance must be one or more of the mechanisms listed below, in a form substantially identical to the relevant sample documents available from the "Financial Assurance" category on the Cleanup Enforcement Model Language and Sample Documents Database at http://cfpub.epa.gov/compliance/models/, and satisfactory to EPA. Respondent may use multiple mechanisms if they are limited to surety bonds guaranteeing payment, letters of credit, trust funds, and/or insurance policies.

a. A surety bond guaranteeing payment and/or performance of the Work that is issued by a surety company among those listed as acceptable sureties on federal bonds as set forth in Circular 570 of the U.S. Department of the Treasury;

b. An irrevocable letter of credit, payable to or at the direction of EPA, that is issued by an entity that has the authority to issue letters of credit and whose letter-of-credit operations are regulated and examined by a federal or state agency;

c. A trust fund established for the benefit of EPA that is administered by a trustee that has the authority to act as a trustee and whose trust operations are regulated and examined by a federal or state agency;

d. A policy of insurance that provides EPA with acceptable rights as a beneficiary thereof and that is issued by an insurance carrier that has the authority to issue insurance policies in the applicable jurisdiction(s) and whose insurance operations are regulated and examined by a federal or state agency;

e. A demonstration by Respondent that Respondent meets the relevant financial test criteria of 40 C.F.R. § 264.143(f) and reporting requirements of this Section for the sum of the Estimated Cost of the Work and the amounts, if any, of other federal, state, or tribal environmental obligations financially assured through the use of a financial test or guarantee; or

f. A guarantee to fund or perform the Work executed in favor of EPA by one of the following: (1) f. direct or indirect parent company of Respondent; or (2) a company that has a "substantial business relationship" (as defined in 40 C.F.R. § 264.141(h)) with Respondent; provided, however, that any company providing such a guarantee must demonstrate to EPA's satisfaction that it meets the relevant

financial test criteria of 40 C.F.R. § 264.143(f) and reporting requirements of this Section for the sum of the Estimated Cost of the Work and the amounts, if any, of other federal, state, or tribal environmental obligations financially assured through the use of a financial test or guarantee.

143. If Respondent provides financial assurance by means of a demonstration or guarantee under Paragraph 142.e or 142.f, the Respondent shall also comply and shall ensure that the guarantors comply with the other relevant criteria and requirements of 40 C.F.R. § 264.143(f) and this Section, including, but not limited to: (a) the initial submission to EPA of required documents from the affected entity's chief financial officer and independent certified public accountant no later than thirty (30) days after the Effective Date; (b) the annual resubmission of such documents within ninety (90) days after the close of each such entity's fiscal year; and (c) the notification of EPA no later than thirty (30) days, in accordance with Paragraph 144, after any such entity determines that it no longer satisfies the relevant financial test criteria and requirements set forth at 40 C.F.R. § 264.143(f)(1). Respondent agrees that EPA may also, based on a belief that an affected entity may no longer meet the financial test requirements of Paragraph 142.e or 142.f, require reports of financial condition at any time from such entity in addition to those specified in this Paragraph. For purposes of this Section, references in 40 C.F.R. Part 264, Subpart H, to: (1) the terms "current closure cost estimate," "current post-closure cost estimate," and "current plugging and abandonment cost estimate" include the Estimated Cost of the Work; (2) the phrase "the sum of the current closure and post-closure cost estimates and the current plugging and abandonment cost estimates" includes the sum of all environmental obligations (including obligations under CERCLA, RCRA, and any other federal, state, or tribal environmental obligation) guaranteed by such company or for which such company is otherwise financially obligated in addition to the Estimated Cost of the Work under this Settlement; (3) the terms "owner" and "operator" include Respondent making a demonstration or obtaining a guarantee under Paragraph 142.e or 142.f; and (4) the terms "facility" and "hazardous waste management facility" include the Site.

144. Respondent shall diligently monitor the adequacy of the financial assurance. If Respondent becomes aware of any information indicating that the financial assurance provided under this Section is inadequate or otherwise no longer satisfies the requirements of this Section, Respondent shall notify EPA of such information within seven (7) days. If EPA determines that the financial assurance provided under this Section is inadequate or otherwise no longer satisfies the requirements of this Section, EPA will notify Respondent of such determination. Respondent shall, within thirty (30) days after notifying EPA or receiving notice from EPA under this Paragraph, secure and submit to EPA for approval a proposal for a revised or alternative financial assurance mechanism that satisfies the requirements of this Section. EPA may extend this deadline for such time as is reasonably necessary for Respondent, in the exercise of due diligence, to secure and submit to EPA a proposal for a revised or alternative financial assurance mechanism, not to exceed sixty (60) days. Respondent shall follow the procedures of Paragraph 146 (Modification of Amount, Form, or Terms of Financial Assurance) in seeking approval of, and submitting documentation for, the revised or alternative financial assurance mechanism. Respondent's inability to secure and submit to EPA financial assurance in accordance with this Section shall in no way excuse performance of any other requirements of

this Settlement, including, without limitation, the obligation of Respondent to complete the Work in accordance with the terms of this Settlement.

145. Access to Financial Assurance.

a. If EPA issues a notice of implementation of a Work Takeover under Paragraph 124, then, in accordance with any applicable financial assurance mechanism, EPA is entitled to: (1) the performance of the Work; and/or (2) require that any funds guaranteed be paid in accordance with Paragraph 145.d.

b. If EPA is notified by the issuer of a financial assurance mechanism that it intends to cancel such mechanism, and the Respondent fails to provide an alternative financial assurance mechanism in accordance with this Section at least thirty (30) days prior to the cancellation date, the funds guaranteed under such mechanism must be paid prior to cancellation in accordance with Paragraph 145.d.

c. If, upon issuance of a notice of implementation of a Work Takeover under Paragraph 124, either: (1) EPA is unable for any reason to promptly secure the resources guaranteed under any applicable financial assurance mechanism, whether in cash or in kind, to continue and complete the Work; or (2) the financial assurance is provided under Paragraph 142.e or 142.f, then EPA may demand an amount, as determined by EPA, sufficient to cover the cost of the remaining Work to be performed. Respondent shall, within twenty (20) days of such demand, pay the amount demanded as directed by EPA.

d. Any amounts required to be paid under this Paragraph 145 shall be, as directed by EPA: (i) paid to EPA in order to facilitate the completion of the Work by EPA or by another person; or (ii) deposited into an interest-bearing account, established at a duly chartered bank or trust company that is insured by the FDIC, in order to facilitate the completion of the Work by another person. If payment is made to EPA, EPA may deposit the payment into the EPA Hazardous Substance Superfund or into the Special Account within the EPA Hazardous Substance Superfund to be retained and used to conduct or finance response actions at or in connection with the Site, or to be transferred by EPA to the EPA Hazardous Substance Superfund.

e. All EPA Work Takeover costs not paid under this Paragraph 145 must be reimbursed as Future Response Costs under Section XIV (Payment of Response Costs).

146. Modification of Amount, Form, or Terms of Financial Assurance. Respondent may submit, on any anniversary of the Effective Date or at any other time agreed to by the Parties, a request to reduce the amount, or change the form or terms, of the financial assurance mechanism. Any such request must be submitted to EPA in accordance with Paragraph 142, and must include an estimate of the cost of the remaining Work, an explanation of the bases for the

cost calculation, and a description of the proposed changes, if any, to the form or terms of the financial assurance. EPA will notify Respondent of its decision to approve or disapprove a requested reduction or change pursuant to this Paragraph. Respondent may reduce the amount of the financial assurance mechanism only in accordance with: (a) EPA's approval; or (b) if there is a dispute, the agreement or written decision resolving such dispute under Section XV (Dispute Resolution). Any decision made by EPA on a request submitted under this Paragraph to change the form or terms of a financial assurance mechanism shall be made in EPA's sole and unreviewable discretion, and such decision shall not be subject to challenge by Respondent pursuant to the dispute resolution provisions of this Settlement or in any other forum. Within thirty (30) days after receipt of EPA's approval of, or the agreement or decision resolving a dispute relating to, the requested modifications pursuant to this Paragraph, Respondent shall submit to EPA documentation of the reduced, revised, or alternative financial assurance mechanism in accordance with Paragraph 142.

147. Release, Cancellation, or Discontinuation of Financial Assurance. Respondent may release, cancel, or discontinue any financial assurance provided under this Section only: (a) if EPA issues a Notice of Completion of Work under Section XXVIII (Notice of Completion of Work); (b) in accordance with EPA's approval of such release, cancellation, or discontinuation; or (c) if there is a dispute regarding the release, cancellation, or discontinuance of any financial assurance, in accordance with the agreement or final decision resolving such dispute under Section XV (Dispute Resolution).

XXVI. MODIFICATION

148. The RPM or OSC may modify any plan or schedule or SOW in writing or by oral direction, provided such modification is consistent with the scope of the Work set out in the Work Plans attached as Appendix C and the Action Memorandum. Any oral modification will be memorialized in writing by EPA promptly, but shall have as its effective date the date of the RPM's or OSC's oral direction. Any other requirements of this Settlement may be modified in writing by mutual agreement of the parties.

149. If Respondent seeks permission to deviate from any approved work plan or schedule or the SOW, Respondent's Project Coordinator shall submit a written request to EPA for approval outlining the proposed modification and its basis. Respondent may not proceed with the requested deviation until receiving oral or written approval from the RPM pursuant to Paragraph 148.

150. No informal advice, guidance, suggestion, or comment by the RPM, OSC or other EPA representatives regarding any deliverable submitted by Respondent shall relieve Respondent of its obligation to obtain any formal approval required by this Settlement, or to comply with all requirements of this Settlement, unless it is formally modified.

XXVII. ADDITIONAL REMOVAL ACTION

151. If EPA determines that additional removal actions not included in the Work Plans attached as Appendix C or other approved plan(s) are necessary to protect public health, welfare,

or the environment, and such additional removal actions are consistent with the Action Memorandum, EPA will notify Respondent of that determination, and the Parties will enter into negotiations to discuss modifying this Agreement to provide for additional removal actions. This Section does not alter or diminish the RPM's authority to make oral modifications to any plan or schedule pursuant to Section XXVI (Modification).

XXVIII. NOTICE OF COMPLETION OF WORK

152. When EPA determines, after EPA's review of the Final Report, that all Work has been fully performed in accordance with this Settlement, with the exception of any continuing obligations required by this Settlement, including, payment of Future Response Costs or record retention, or that MCE or the then-current owner of Meramec Caverns has elected to discontinue offering tours of Meramec Caverns to the public, EPA will provide written notice to Respondent. If EPA determines that such Work has not been completed in accordance with this Settlement, EPA will notify Respondent, provide a list of the deficiencies, and require that Respondent modify the Work Plans if appropriate in order to correct such deficiencies. Respondent shall implement the modified and approved Work Plans and shall submit a modified Final Report in accordance with the EPA notice. Failure by Respondent to implement the approved modified Work Plans shall be a violation of this Settlement.

XXIX. INTEGRATION/APPENDICES

153. This Settlement and its appendices constitutes the final, complete, and exclusive agreement and understanding among the Parties with respect to the settlement embodied in this Settlement. The parties acknowledge that there are no representations, agreements, or understandings relating to the settlement other than those expressly contained in this Settlement. The following appendices are attached to and incorporated into this Settlement:

a. Appendix A is the Affected Property.

b. Appendix B is the description and/or map of the Site.

c. Appendix C is the various RI/FS OU2 Work Plans.

d. Appendix D is the Action Memorandum.

XXX. EFFECTIVE DATE

154. This Settlement shall be effective when the Settlement is signed by the EPA, Region 7, Superfund Division Director and electronic notice has been provided to the Respondent.

Signature Page for Removal Settlement Regarding Oak Grove Village Superfund Site

IT IS SO AGREED AND ORDERED:

U.S. ENVIRONMENTAL PROTECTION AGENCY:

7/19/2016
Dated

Mary P. Peterson
Mary P. Peterson
Director
Superfund Division

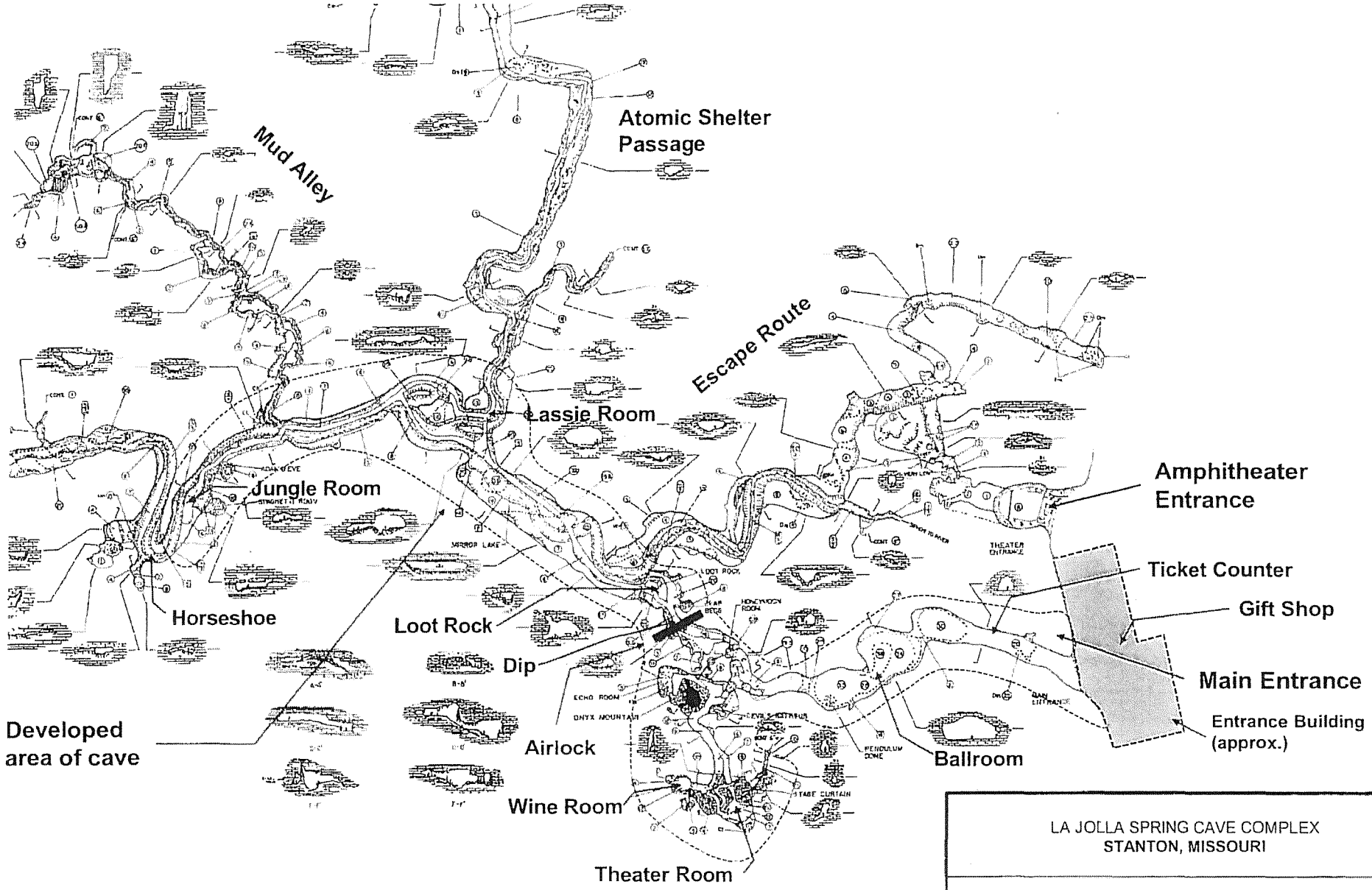
Signature Page for Removal Settlement Regarding Oak Grove Village Superfund Site

FOR TRW Automotive U.S. LLC:

6-22-16
Dated

[Name] Mariann McNally
[Title] Assistant Secretary
[Company] TRW Automotive U.S. LLC
[Address] 12001 Tech Center Dr.
Livonia, MI 48150

APPENDIX A
ADMINISTRATIVE SETTLEMENT AGREEMENT
CERCLA DOCKET No. CERCLA-07-2016-0012

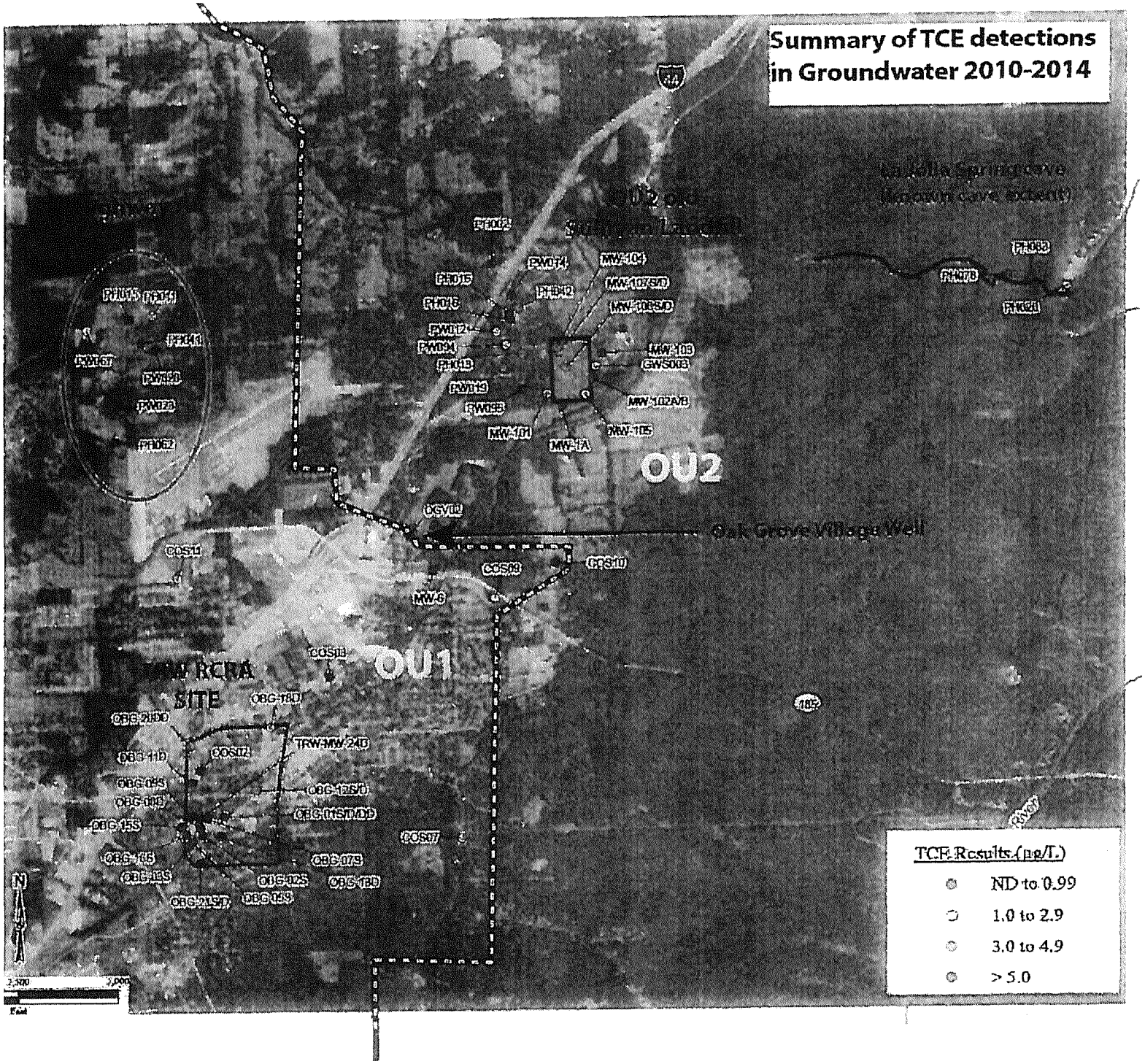


LA JOLLA SPRING CAVE COMPLEX
STANTON, MISSOURI

CAVE LAYOUT

ARCADIS Design & Consultancy for natural and built assets

APPENDIX B
ADMINISTRATIVE SETTLEMENT AGREEMENT
CERCLA DOCKET No. CERCLA-07-2016-0012


Summary of TCE detections in Groundwater 2010-2014
OU2
OU1
Oak Grove Village Well
TCE Results (µg/L)
ND to 0.99
1.0 to 2.9
3.0 to 4.9
> 5.0

APPENDIX C
ADMINISTRATIVE SETTLEMENT AGREEMENT
CERCLA DOCKET No. CERCLA-07-2016-0012

ARCADIS

Infrastructure Water Environment Buildings

Imagine the result

TRW Automotive U.S. LLC

Cave Air Work Plan

La Jolla Spring Cave Complex
Stanton, Missouri

May 29, 2015

ARCADIS

Michael Cobb
Principal Scientist

Bretton C. Overholtzer, P.E.
Senior Project Engineer

John P. Shonfelt, P.G.
Senior Project Manager

Cave Air Work Plan

La Jolla Spring Cave Complex
Stanton, Missouri

Prepared for:
TRW Automotive U.S. LLC

Prepared by:
ARCADIS U.S., Inc.
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Our Ref.:
KC001590.0003

Date:
May 29, 2015

Table of Contents

Tables

Figure

1. Introduction

This work plan describes interim measures designed to improve air-quality in the La Jolla Spring Cave Complex, located in Stanton, Missouri. The plan entails investigations, design, construction and testing of a temporary air barrier in a portion of the cave referred to as the Horseshoe, and a temporary air-lock system in an area referred to as the Dip. This work is a collaborative effort of Meramec Caverns, Ozark Underground Laboratories (OUL), and ARCADIS U.S., Inc. acting on behalf of TRW Automotive U.S. LLC.

2. Background

The La Jolla Spring Cave Complex is a natural cave system in Franklin County, Missouri (Figure 1). A portion of the cave is privately owned, and operated as a tourist attraction. A stream flows through the cave from west to east, discharging to the Meramec River at La Jolla Spring. Sampling has identified the compound trichloroethene (TCE) in the both the cave stream and cave air. The presence of TCE in the cave stream was first documented in 1990. TCE has also been detected in cave air since it was first sampled in 2002. Starting in 2013, USEPA began a program of periodic air sampling at seven locations inside the cave. The sampling results are summarized in the table below. Sample locations are shown on Figure 1.

Table 1. TCE Concentrations (µg/m^3) in Cave Air

Sample Location	Mar. 2013	Aug. 2013	Jan. 2014	Mar. 2014	Jun. 2014	Aug. 2014
Gift Shop	<1.2	97.5	5.37	1.13	125	143
Ticket Counter	NS	NS	NS	4.83	183	193
Ballroom[a]	5.16 / 4.57	138	20	4.51	169	133
Theater Room	4.19	<0.43	12.3	4.35	1.29	0.698
Loot Rock[b]	7.09	153 / 164	33.8 / 40.1	14 / 13.9	220 / 217	224 / 189
Lassie	18.2	117	48.8	21.4	196	176
Jungle Room	22.4	177	64.8	17.4	252	240

Data as reported by Missouri Department of Health and Senior Services, December 12, 2014, Letter Health Consultation, La Jolla Spring Cave Complex, Stanton, MO.
Results in micrograms per cubic meter (µg/m^3); NS = Not sampled
Samples collected over 24-hour period.
[a] Results for March 2013 include a sample collected from the Ballroom and a sample collected from the Ballroom Stage.
[b] Results include the original sample and field duplicate sample.

To limit potential worker exposure, the cave owner undertook several corrective measures:

- Upgrades to an existing sliding-door enclosure to the gift-shop and cafeteria areas, including an air-curtain (initially installed for radon mitigation).

- Increasing the proportion of outside air drawn into the heating and air-conditioning system serving the gift shop and cafeteria areas.

- Adjustments to work-place practices, including moving break areas outside of the cave.

These measures have had the beneficial effect of limiting potential worker exposure, and improving air quality in the front-portion of the cave where workers spend the most time. The additional measures described in this work plan are intended to test whether further air quality improvements can be achieved throughout the developed portions of the cave.

3. Current Understanding of Cave Air Circulation

Based on currently available data and conversations with OUL, air circulation in the cave system is thought to be primarily driven by three factors:

- **Temperature differences between cave and outside air.** When the outside air is warmer than cave air (warm-condition), the cooler cave air is more dense than outside air, and tends to flow out of lower elevation cave openings, drawing replacement air in from higher elevation openings. When outside air is cooler than cave air (cold-condition), the pattern is reversed: warmer-lighter cave air rises out high-elevation openings, drawing replacement air in through low-elevation openings.

- **Elevation of cave openings.** The elevation of a cave opening controls whether it will be an air-inlet or outlet under warm or cold conditions. The two major known cave openings, the Main Entrance and the Theater Entrance, are both at the bottom of the cave system, and so act as warm-condition outlets and cold-condition outlets. No major high-elevation cave openings are known, thus high-elevation air-exchange likely occurs via numerous smaller fissures.

- **Size of cave openings**. The rate of air-circulation also depends on the efficiency of the air-flow between the inlets and outlets. Tight openings create resistance to air-flow; wide-open passages and openings promote greater air-flow.

As a generality, the warm-conditions and cold-conditions prevail in the summer and winter, respectively, when outside temperatures are consistently either above or below the nearly constant cave air temperature (57°F). Air-flow rates likely vary within a given day's heating-cooling cycle; potentially reversing if the range of temperatures oscillates above and below the cave temperature.

Based on cave-owner observations and preliminary air flow measurements by OUL, probable inlets and outlets to the developed portion of the cave are summarized in Table 2, below (see Figure 1 for reference).

Table 2. Air Inlets and Outlets

Probable Warm-Condition Air-Inlets (and cold-condition outlets)	Probable Warm-Condition Air-Outlets (and cold-condition inlets)
• Main stem of cave (upstream of Jungle Room • Mud Alley • Atomic Shelter Passage • Wine Room (via ventilation boreholes)	• Main Entrance • Theater Entrance

4. Concept and Objectives for Interim Measures

Based on the current understanding of the cave system, the project team has identified two air-control measures that are anticipated to have a beneficial effect on air quality in the developed portion of the cave:

- An air-barrier in a portion of the cave referred to as the Horseshoe (identified on Figure 1), on the main stem of the cave upstream of the Jungle Room. The goal of this structure is to restrict the volume of air migrating from the undeveloped portion of the cave into the developed portion of the cave under warm-conditions. The barrier would be constructed to allow opening under cold-conditions, when up-cave air-flow may be beneficial.

- An air-lock system in an area referred to as the Dip (identified on Figure 1). This structure would consist of a series of doors that would isolate the front

areas of the cave (including Ballroom, Gift Shop, Wine Room and Theater Room) from the main stem of the cave and the cave stream. The goal of the air-lock is to reduce the flow of upstream cave air into the most frequently occupied section of the cave.

Because of the complexity of cave air circulation patterns, the effects of these two measures are uncertain. For this reason, the structures will be constructed as temporary features, intended to allow testing their effects, separately and in combination. The data from this effort will be used to guide potential future design, construction and operation of permanent structures, if needed.

5. Scope-of-Work

The scope-of-work is organized into three phases:

- Pre-Design Investigation to establish existing conditions and gather data needed for designing the air-control structures
- Design and construction of the temporary air-control structures
- Performance testing, to evaluate the effects of the structures on airflow and air quality.

5.1 Pre-Design Investigation

The project team will undertake a pre-design investigation to meet the following objectives:

- Identify and quantify major air inputs and outlets
- Gather pre-design data for construction of temporary air-control structures
- Evaluate warm-weather day-time air circulation variability
- Refine understanding of cave air circulation patterns
- Establish existing air-quality conditions

The project team will conduct a cave reconnaissance to more-thoroughly identify the locations of air inlets and outlets affecting the developed portion of the cave. The study will employ a combination of approaches including direct observations, airflow measurements, temperature monitoring, and measurements of natural alpha radiation concentrations.

This preliminary study will also include an inspection of the proposed air-control structure sites, to identify the most advantageous construction locations, and identify construction options. The locations will be photographed, diagramed and measured. The nature of surfaces will be examined and noted (e.g., rock, dense clay, soft sediment).

The baseline monitoring tasks of the predesign investigation include air-flow and air-quality testing at a number of locations distributed throughout the cave. The planned locations for each task are summarized in Table 3, below, and shown on Figure 1. Note that these locations may be adjusted based on the findings of the preliminary reconnaissance (for instance, if significant additional inlets or outlets are identified).

Table 3. Baseline Air-Sampling and Gauging Locations

Task	Preliminary List of Locations
48-hour Air Velocity Logging (collected by USGS)	1. Jungle Room 2. Dip
Volumetric Air Flow Gauging	1. Jungle Room 2. Mud Alley 3. Atomic Passage east 4. Atomic Passage west 5. Dip 6. Escape Route 7. Theater Entrance
Air Quality Sampling	1. Upstream of air-dam 2. Jungle Room* 3. Lassie Room* 4. Loot Rock* 5. Theater Room* 6. Ballroom* 7. Ticket Counter* 8. Gift Shop* 9. Mud Alley 10. Atomic Shelter Passage (head of trail) 11. Atomic Shelter Passage tributary 12. Theater Entrance 13. Outside air

*Existing quarterly sampling location.

Air circulation patterns will be evaluated via two tasks.

1. Air-velocity and flow-direction will be measured continuously for at least a 48-hour period at two locations in the cave (identified in the table above), to evaluate short-term variability of air circulation under typical warm-season conditions. Continuous measurements of outside air temperature will be collected simultaneously. Data from the study will be used to identify timing of peak and minimum flow rates within a daily heating cycle. Testing will be conducted using a tripod-mounted data-logging anemometer. [Note that data collected by the U.S. Geological Survey (USGS) may be used in lieu of additional testing by the project team, if available data satisfactorily establishes a patterns of short-term air flow variability].

2. Volumetric air-flow rates will be measured at approximately seven locations in the cave (identified in the table above) at multiple times during a normal summer daily temperature cycle. Continuous measurements of outside air temperature will be collected simultaneously. Final selection of locations will be made based on field identification of suitable cave passages, including considerations such as size, straightness, and accessibility. The dimensions of the cave passage at each gauging point will be measured to determine a cross-sectional area. Air flow measurements will be recorded with a hand-held anemometer at multiple points within the passage to obtain an average air-flow rate.

Air quality sampling will be conducted under warm-condition at the locations identified in Table 3 and Figure 1. Data from this sampling event will be used as a reference to help evaluate the effect of the air-control structures on cave air quality. Stainless steel canisters (6-liter) under a vacuum of at least -25 inches of mercury (in. Hg) will be supplied from a laboratory with current Environmental Laboratory Approval Program (ELAP) certification. Sample canisters will be batch certified clean, supplied with vacuum gauges and pre-set flow controllers capable of collecting a sample over an 24-hour time period. Samples will be collected from the approximate breathing height (3 to 5 feet above ground) of a site worker. One blind-duplicate sample will be collected. Once each canister is full (i.e., -5 in. Hg remaining, as measured by a pressure gauge or sample period has elapsed), it will be sealed and labeled with the sample identification number. Samples will be either shipped via overnight carrier or driven directly to the analytical laboratory for analysis of chlorinated volatile organic compounds (VOCs) via USEPA Method TO-15.

5.2 Design and Installation of Temporary Air Control Structures

The project team will use the Pre-Design Investigation data to develop a simple design package for each of the two temporary air-control structures, suitable for implementation by the cave-owner's designated construction contractor.

Based on the current understanding, the design of the air-barrier in the Horseshoe will need to incorporate the following considerations:

- The barrier must be able to open and shut. Allowing unimpeded air-circulation in the open condition is needed to permit testing and may be needed as an operational condition, for instance under cold-condition air circulation patterns.

- The barrier must span the cave stream, and allow water to pass relatively unimpeded. Stream levels are known to rise and fall several feet depending on the season and in response to storm events.

The proposed location of the barrier is on the western (upstream) arm of a horseshoe bend in the cave. This location is near the developed portion of the cave (to simplify construction, operation and maintenance) but also out of sight from the developed portion of the cave. It is currently anticipated that the barrier will comprise a simple lumber frame, with a hinged plywood gate. Additional materials may include Plexiglas and flexible plastic sheeting, similar to cold-storage drapes.

The design of the air-lock system in the Dip area will need to permit tour groups to pass through the Dip area with minimal difficulty. The two doors of the air-lock must be spaced sufficiently apart to permit a full tour group to congregate comfortably within. It is currently anticipated that the airlock doors will each comprise a simple lumber frame, with hinged plywood doors.

Construction of the control structures will be completed by the cave owner's designated contractor, and will be overseen by cave personnel to minimize interference with operations.

5.3 Performance Testing

After construction of the air-control structures, testing will be completed to understand their impacts on both air circulation and air quality. The two types of testing will be conducted separately, as described below.

5.3.1 Air Circulation Testing

Testing will be completed to measure the effect on air-circulation patterns of opening and closing the two air-control structures. Testing will comprise air-flow monitoring at approximately seven air-flow locations, under each combination of control-structure closures (i.e., both structures open, barrier-closed/lock-open, barrier-open/lock-closed, both structures closed). Air circulation patterns are anticipated to equilibrate rapidly after each change to the system; thus this testing can be done systematically over a short period of time (e.g., 2 to 3 days). Outdoor temperature will be monitored continuously throughout the study. Flow measurements at multiple points in the temperature cycle may be collected at selected major points, where feasible.

5.3.2 Air Quality Sampling

Air quality sampling will be conducted after air flow gauging is complete. Sampling will be conducted under three scenarios:

- air barrier closed, air lock open
- air barrier open, air lock closed
- both structures closed

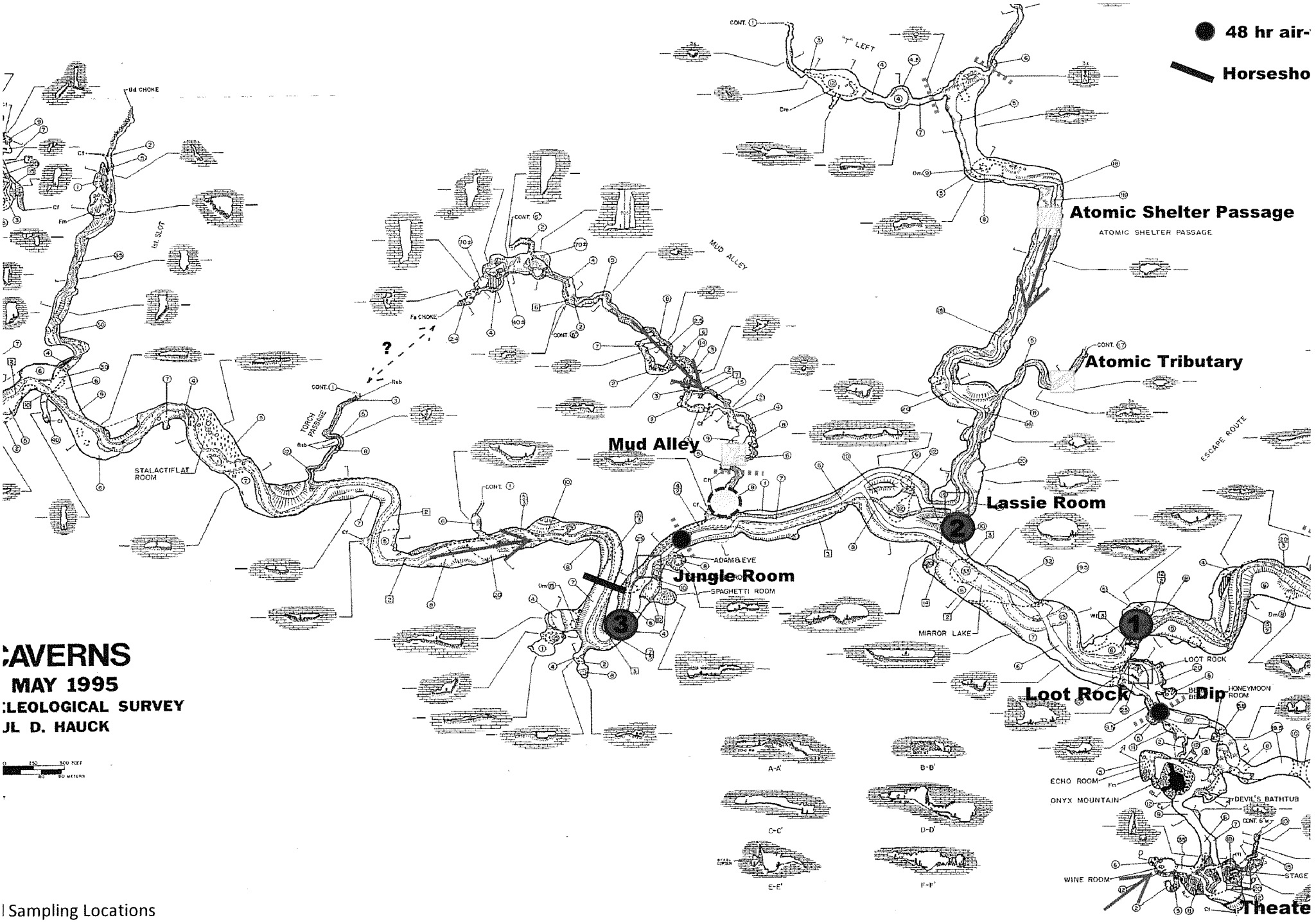
Sampling under each condition will be conducted after the a period of equilibration following the opening or closure of the control structures. Based on current understanding of cave air-circulation patterns, it is currently anticipated that TCE concentrations in air will reach equilibrium within three days after each modification. This timeframe will be reevaluated and adjusted based on air flow data collected prior to this phase of the study. Longer equilibration times may be allowed, if appropriate.

The sampling program will follow the scope and methodology of the pre-design sampling round. Locations of the proposed samples are summarized in Table 3 and identified in Figure 1, but may be adapted based on the Pre-Design Investigation data.

6. Reporting and Recommendations

When the planned work is completed, the project team will prepare a report to document the investigations, construction of the air-flow control structures, and measured performance. The report may include recommendations for additional investigations, interim operation of the temporary air-control structures, or for permanent installations, if appropriate. Recommendations to conduct any additional

work will be contingent on the residual TCE concentrations, and expected costs/benefits of the measure.


48 hr air-
Horsesho
Atomic Shelter Passage
ATOMIC SHELTER PASSAGE
Atomic Tributary
Mud Alley
Lassie Room
Jungle Room
Loot Rock
Dip
CAVERNS
MAY 1995
GEOLOGICAL SURVEY
JUL D. HAUCK
Sampling Locations
ocation if tributary water is accessible
Theate

ARCADIS Design & Consultancy for natural and built assets

TRW Automotive U.S. LLC

PHASE TWO CAVE AIR WORK PLAN

La Jolla Spring Cave Complex

Stanton, Missouri

February 2, 2016

PHASE TWO CAVE AIR WORK PLAN

Michael Cobb
Principal Scientist

Bretton C. Overholtzer, P.E.
Senior Project Engineer

John P. Shonfelt, P.G.
Senior Project Manager

Prepared for:

TRW Automotive U.S. LLC

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Tel 913 492 0900
Fax 913 492 0902

Our Ref.:

KC001590.0004

Date:

February 2, 2016

CONTENTS

FIGURE

ATTACHMENT

1 INTRODUCTION

This work plan describes measures planned to address air-quality in the La Jolla Spring Cave Complex, located in Stanton, Missouri. The plan entails enhancements to interim measures completed in 2015, and additional tasks to assess and optimize performance of those measures. This work is a collaborative effort of Meramec Caverns, Ozark Underground Laboratories (OUL), and Arcadis U.S., Inc. acting on behalf of TRW Automotive U.S. LLC.

2 BACKGROUND

The La Jolla Spring Cave Complex is a natural cave system in Franklin County, Missouri. **Figure 1** shows the layout of the cave and its key features. A portion of the cave is privately owned, and operated as a tourist attraction. A stream flows through the cave from west to east, discharging to the Meramec River at La Jolla Spring. Sampling has identified the compound trichloroethene (TCE) in both the cave stream and cave air.

In consultation with the United States Environmental Protection Agency (EPA) and United States Geological Survey (USGS), the cave owner undertook several measures to reduce potential employee exposure to TCE:

- Upgrades to an existing sliding-door enclosure to the gift-shop and cafeteria areas, including an air-curtain (initially installed for radon mitigation).
- Increasing the proportion of outside air drawn into the heating and air-conditioning system serving the gift shop and cafeteria areas.
- Adjustments to work-place practices, including moving break areas outside of the cave.

Working collaboratively with the Meramec Caverns, the USGS and USEPA, Arcadis prepared a Cave Air Work Plan (May 29, 2015) containing plans for testing two potential air-control measures. The proposed measures included:

- An air-barrier (or air dam), which would have been located upstream of the Jungle Room, to limit the flow of air from deeper in the cave. After further study, this concept was abandoned out of concern that the cave's frequent flooding would pose major design and operational challenges.
- An airlock, located in the "Dip" area of the cave, to isolate the front area of the cave (including the entrance building) from air carried from deeper in the cave. The airlock was constructed in June 2015 as a temporary structure that would allow testing and, if effective, provide interim air-control until a permanent structure could be constructed.

As an additional measure, the cave-owner reconfigured the Amphitheater area of the cave to remove obstructions to air-flow, and increase air circulation through the portion of the cave west (up-cave) of the airlock. This work was completed in September 2015.

Periodic air-sampling and related investigations were completed throughout 2015 to evaluate performance of the air-control measures, and improve understanding of air transport patterns. Arcadis provided an analysis of these studies to EPA and USGS at a meeting on January 27, 2016. Excerpts of the presentation are provided as **Attachment A** of this report.

3 OBJECTIVES

The scope-of-work described in this work plan is intended as a continuation of the incremental air control efforts undertaken in 2015. The objectives are to design and construct air-control measures that:

- Further reduce TCE concentrations in cave air in the entrance building and toured areas of the cave.
- Limit unintended side-effects of changed cave ventilation patterns, including increased condensation and mold growth.
- Permit adjustable implementation (e.g., opening or closing) that allows the control measures to be tested and optimized, as needed.

An additional objective is to implement the planned air-control measures prior to the 2016 tourist season.

4 SCOPE-OF-WORK

The scope-of-work includes the following four components:

- Construct a permanent airlock in the Dip area, replacing the temporary structure constructed in 2015
- Upgrade air-sealing and ventilation control at the main entrance
- Reconstruct the exterior wall of the Amphitheater to improve ventilation control.
- Study potential air bypasses in front of cave

These tasks were originally proposed by OUL, and are described in their December 11, 2015 Report, entitled "Recommendations for Lowering TCE Concentrations In Cave Air at Meramec Caverns by Installing Selected Passage Closures." A synopsis of each task is provided below:

Airlock at Dip

The existing temporary airlocks present in the Dip will be removed and replaced with permanent structures. As with the temporary airlock, the permanent airlock will consist of two sets of doors, spaced approximately 100 feet apart. The major design elements include the following:

- Door framing and walls connecting to the cave will be constructed of plastic lumber, in lieu of wood, to limit warping and swelling and prevent mold growth.
- Joints where air may permeate will be caulked.
- Each of the four doors (two in each segment of the airlock) will be commercial-grade full-glass hinged doors.
- The doors will swing toward the cave entrance, be manually opened and closed, and include latching mechanisms that ensure a tight air seal.
- A signal system will be installed that indicates whether one or both air lock doors are open, to avoid accidental simultaneous openings of both sets of doors.
- To allow flood waters to flow across through the dip area without damaging the airlock, each set of doors will be constructed above a concrete-lined trench, with drainage grates on each side of the door installed flush with walking surface. To prevent air migration under the doors, the trench will be designed to maintain a minimum level of standing water, at least one inch above bottom sills of doors.

When in-use, tour groups and cave workers will pass through the air-lock, by opening and closing one set of doors at a time. The airlock is intended to be used under warm-season conditions, when the air flow direction is toward the front of the cave, and to be left open under cold-season conditions, when air is flowing up into the cave. Operational guidelines for the airlock will be developed in consultation with the cave-owner after construction and additional testing is complete.

Main Entrance Air Sealing

The sheet-metal wall enclosing the front of the cave above the entrance building will be modified to improve air-sealing, and allow better control of ventilation. This construction will improve upon temporary measures completed in 2015, including spot-air-sealing and plastic sheeting, undertaken to limit the infiltration of warm-moist outside air that was causing condensation issues between the gift-shop and ticket counter.

The major design elements include the following:

- Removal of the existing sheet-metal siding and windows.
- Re-siding the cave opening with tongue and groove plastic-lumber.
- Installing approximately 5 new vinyl-clad windows
- Air-sealing with spray-foam insulation and caulk, where appropriate, to reduce air leakage through the reconstructed wall and at the intersection with the cave wall.

It is anticipated that windows will be kept closed throughout the warm season, in particular when outside air dew-points are above the cave air temperature. Opening the windows partly or fully, may be appropriate under spring, fall and winter conditions, to promote clear air-circulation. Operational guidelines for the windows will be developed in consultation with the cave-owner after construction and testing is complete.

Amphitheater Entrance Ventilation Control

OUL has proposed changes to the Amphitheater entrance to improve control of air-flow in and out of the cave, improving upon the temporary changes completed in September 2015. The plan entails reconstructing the entrance enclosure with the following objectives:

- Include sufficient openings for air flow such that air may flow freely in and out of the natural cave openings with no appreciable restriction.
- Include design elements that allow air-flow openings to be reduced or closed, if appropriate.
- Limit leakage of air through uncontrolled openings (e.g., joints between the wall and cave) to improve control of air-flow control
- Maintain adequate security to prevent trespassers from entering the cave.

The specifics of these modifications will be determined in consultation with the cave owners after an additional site visit, and further study, as described below. Note that the current, temporary modifications to the Amphitheater entrance are believed to function adequately for typical summer conditions; therefore, the proposed permanent modifications are not needed prior to the 2016 tourist season.

Additional Air-Flow Investigations

In addition to the air-control measures described above, OUL has recommended additional study in several areas of the cave to better understand cave-air circulation patterns. These data are needed to optimize performance of the existing control measures, and evaluate what additional measures (if any) have promise to further reduce TCE concentrations. The tasks include the following:

- Investigate whether cave passages existing above the natural entrance may bypass the walled main entrance and introduce warm outside air into the cave, contributing to condensation and mold growth.
- Evaluate potential additional warm-season air discharge at a point north of the Amphitheater (on the Escape Route), which may potentially be used to further control cave air circulation.

The proposed studies will be completed by physical exploration, along with air-flow and micro-climate measurements (temperature and relative humidity).

5 CONCURRENT STUDIES

The scope of work described above will be completed in concert with planned air-sampling events proposed by EPA and with cooperation and input from Arcadis and OUL. Air quality data from these concurrent studies will be used to evaluate performance of the air-control measures, track continued improvements in air-quality from the completed measures, and assist in identifying what additional investigations and/or control measures may be appropriate beyond the current scope.

6 SCHEDULE

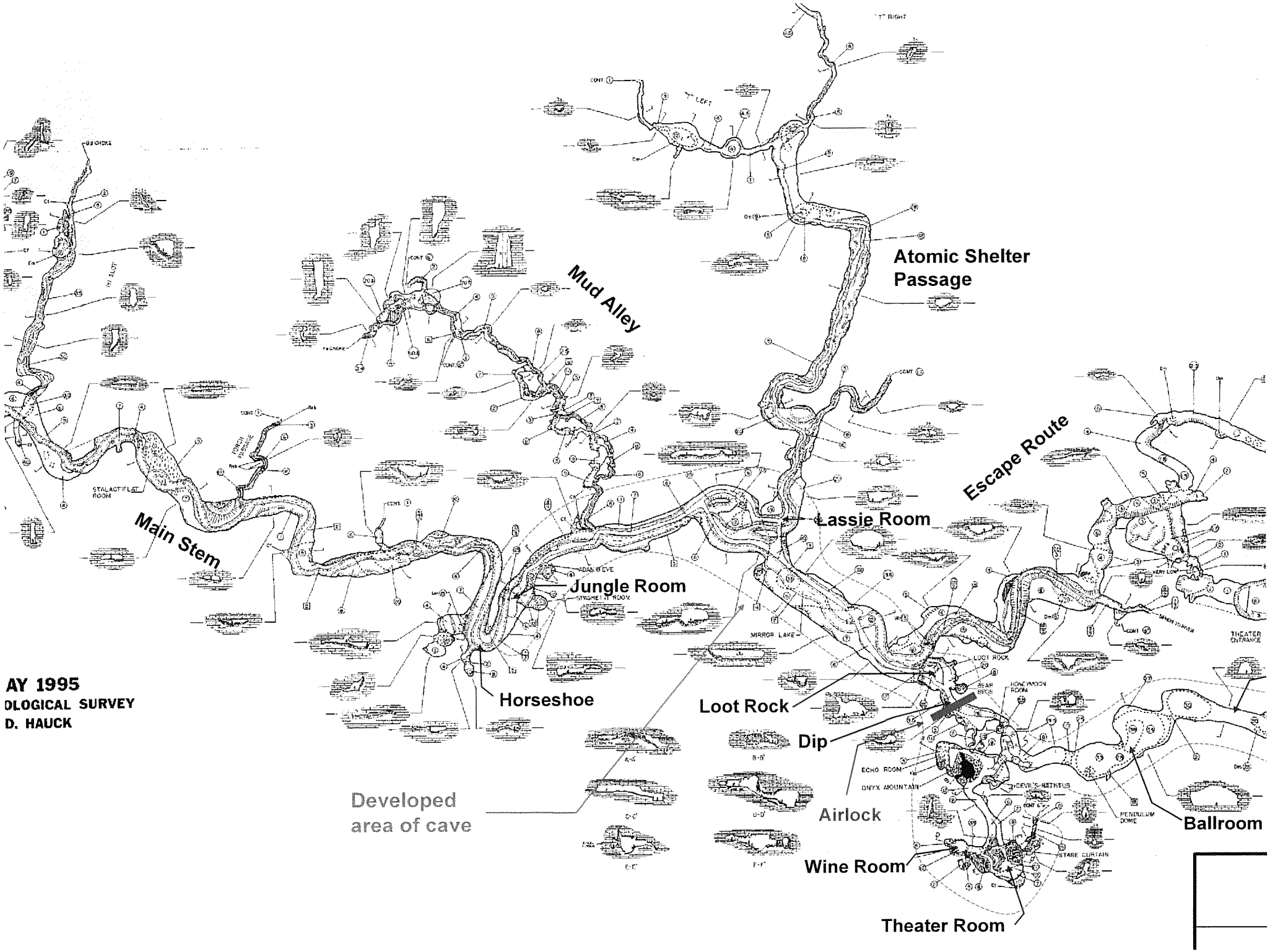
The air-control construction projects are planned for implementation prior to the start of the 2016 tourist season. Specifically:

- Construction of the permanent air-lock system is expected to be completed by late-March 2016, subject to contractor availability.
- Main entrance air sealing construction activities will be performed simultaneously or after air-lock construction, and are expected to be complete before mid-April 2016.
- The additional air-flow investigations will be undertaken after the proposed construction activities are complete, but scheduling will be weather dependent. Ideally, with work will be completed under warm-season conditions, when outside air-temperatures are at least 65 degrees Fahrenheit.
- Changes to the Amphitheater entrance are expected to be completed after some or all of the additional air-flow investigations are complete, and the project team and cave owner reach consensus on the design. As noted above, the existing temporary modifications to the Amphitheater are performing as appropriate for warm-season air-flow conditions, therefore completion of this task ahead of the tourist season would provide no additional benefit.

7 NOTIFICATION AND REPORTING

Arcadis and/or the cave owner will notify EPA at least one week in advance of construction activities. EPA will be notified when projects are complete, and informed of any changes from the anticipated design. Data generated and performance observations will be shared with EPA as soon as feasible, on a rolling basis throughout the program.

FIGURES


Atomic Shelter Passage
Mud Alley
Escape Route
Lassie Room
Main Stem
Jungle Room
Horseshoe
Loot Rock
Dip
Airlock
Ballroom
Wine Room
Theater Room
Developed area of cave
AY 1995
OLOGICAL SURVEY
D. HAUCK

ATTACHMENT 1

Excerpts from January 27, 2016 Meeting Presentation

ARCADIS Design & Consultancy for natural and built assets

Selected slides from...

LA JOLLA SPRING CAVE COMPLEX

Air Control Measures

January 27, 2016 Meeting
Kansas City

Confidential Settlement Communication

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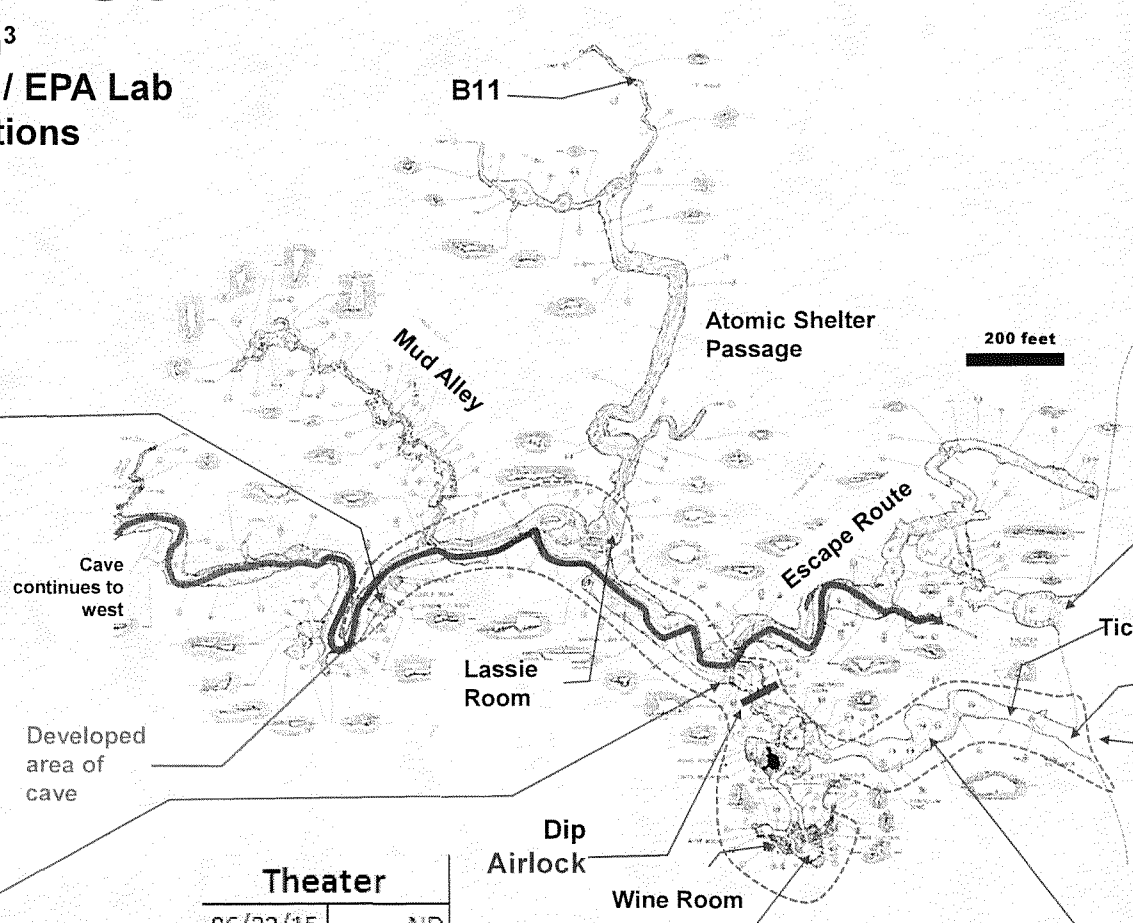
CSM and Current Conditions

TCE in Cave Air

ARCADIS for natural and built assets

Values in ug/m^3
24-hr Canister / EPA Lab
Selected Locations



Amphitheater	
06/22/15	125
06/24/15	142
07/28/15	220
08/25/15	250
09/18/15	168
09/23/15	159
10/22/15	410
11/30/15	1.0

Jungle Room	
06/22/15	147
06/24/15	137
07/28/15	250
08/25/15	300
09/18/15	207
09/23/15	241
10/22/15	660
11/30/15	52

Gift Shop	
06/22/15	100
06/24/15	10
07/28/15	110
08/25/15	14
09/18/15	19
09/23/15	15
10/22/15	51
11/30/15	6.5

Loot Rock	
06/22/15	114
06/24/15	--
07/28/15	230
08/25/15	300
09/18/15	158
09/23/15	181
10/22/15	590
11/30/15	37

Theater	
06/22/15	ND
06/24/15	--
07/28/15	4
08/25/15	13
09/18/15	4
09/23/15	18
10/22/15	45
11/30/15	33

	Air-Lock	Amphi-theater	7-Day Ave Temp (F)
06/22/15	Open	Normal	76
06/24/15	Closed	Normal	76
07/28/15	Open	Normal	79
08/25/15	Closed	Normal	68
09/18/15	Closed	Opened	69
09/23/15	Closed	Opened	69
10/22/15	Closed	Opened	58
11/30/15	Closed	Opened	46

Ballroom	
06/22/15	127
06/24/15	24
07/28/15	170
08/25/15	43
09/18/15	56.2
09/23/15	55
10/22/15	150
11/30/15	43

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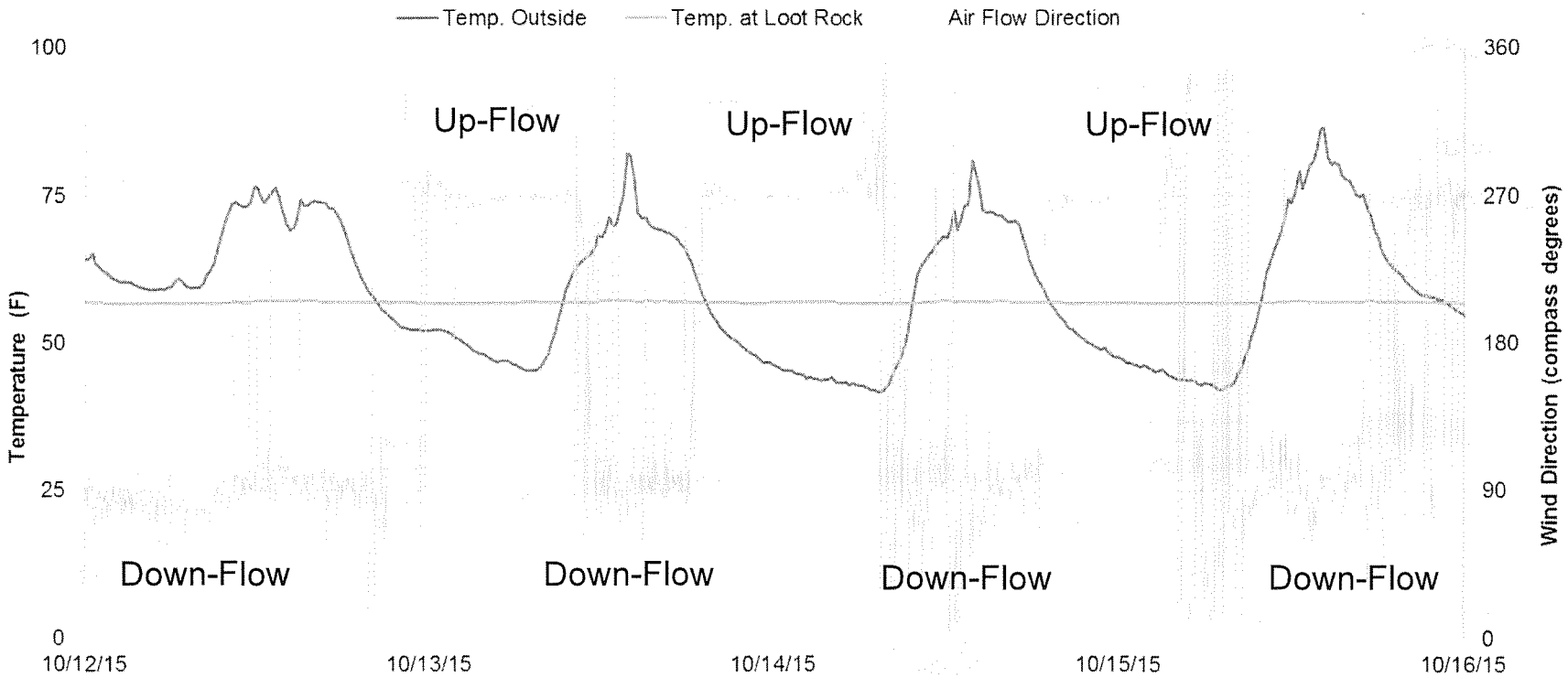
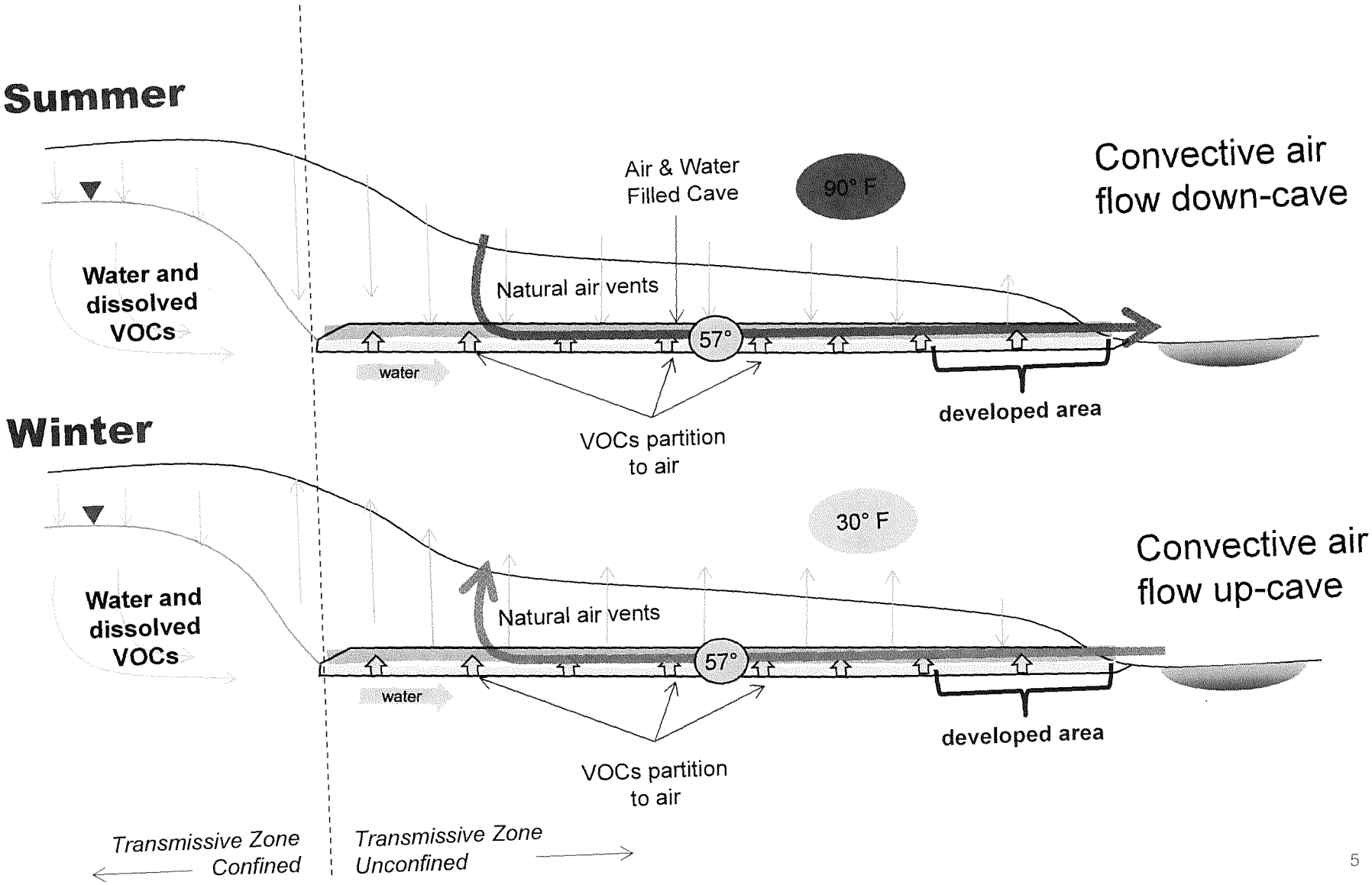
Temperature Sensitivity



USGS Anemometer Data – Station near Jungle Room

- Direction of flow reverses almost instantaneously at temperatures inversions

Cave Air Circulation

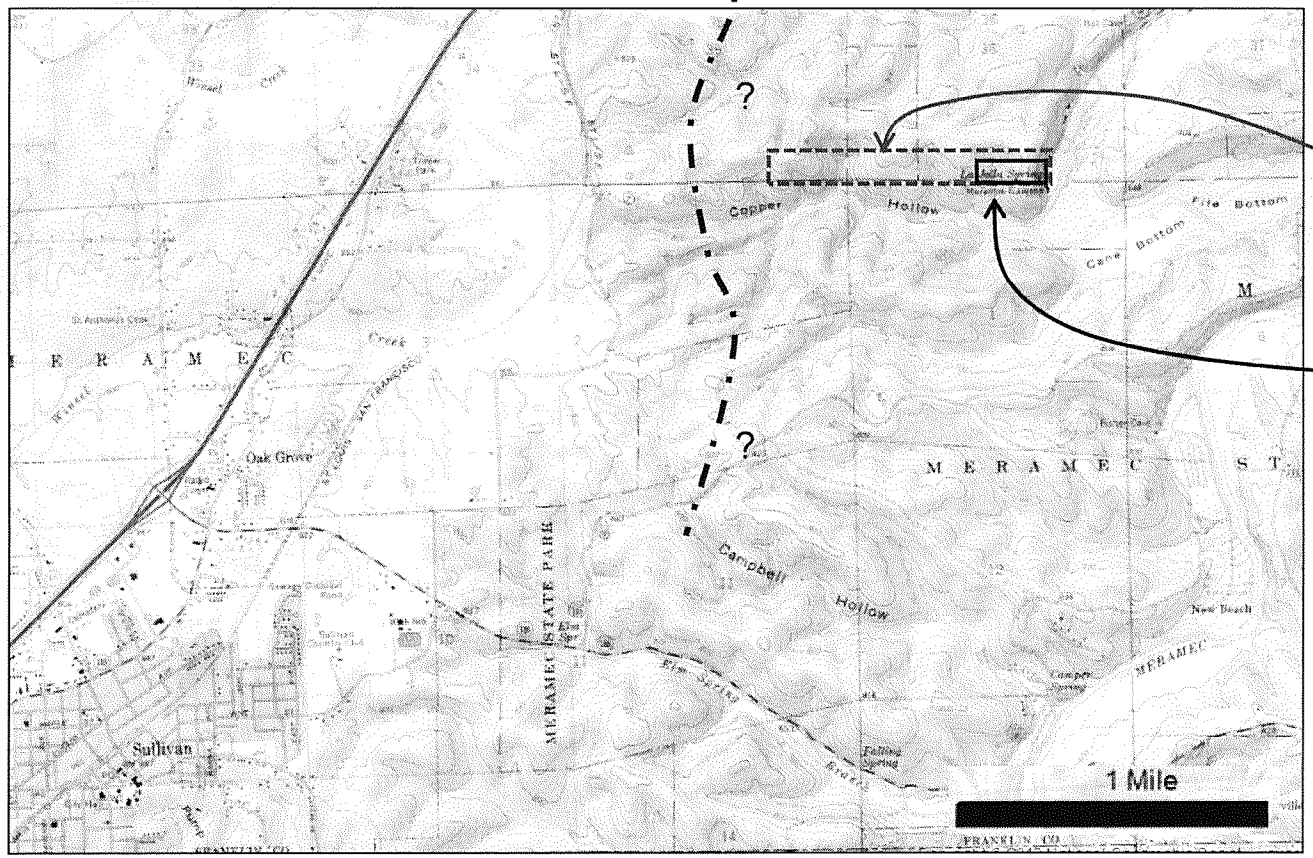


Explored Cave Extent

ARCADIS for natural and built assets

Cave-Strata Confined
(water-filled porosity)

Cave-Strata Unconfined
(air/water filled porosity)



Approx. explored extent of Meramec Cavern (~ 1 mi.)

Developed portion of cave (~1200 ft)

In Sullivan/Oak Grove area, stratigraphic horizon of cave is >100 feet below water table.

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TCE Loading and Flushing

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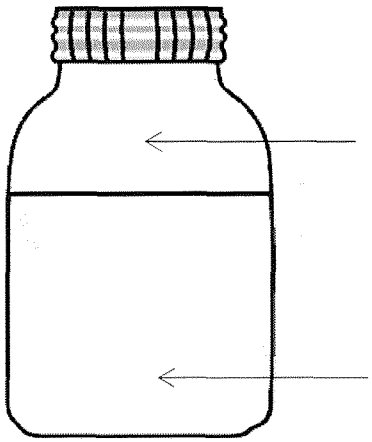

Closed Headspace at Equilibrium

~1500 µg/m^3 TCE in air

4 µg/L TCE @ 57° in water

TCE loading from water to air

Diffusion from rock

Concentration reflects balance of loading and flushing (air residence time)

Clean air flux through cave

TCE and Residence Time

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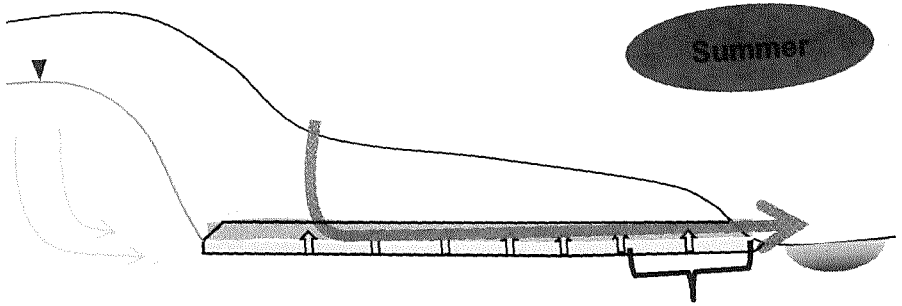

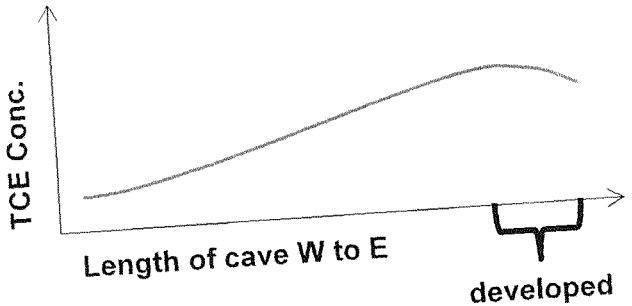

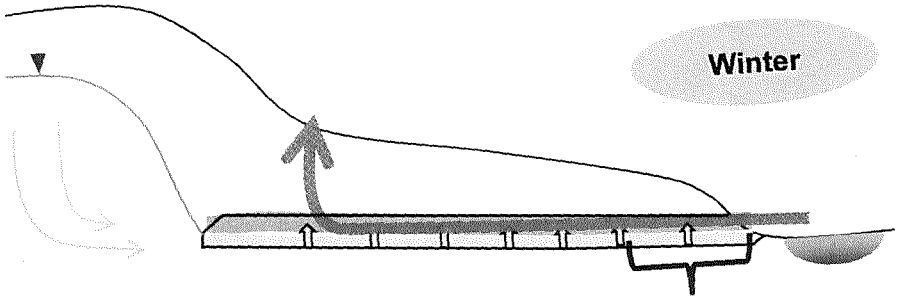

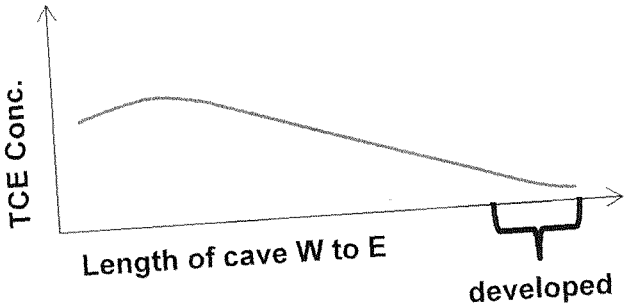

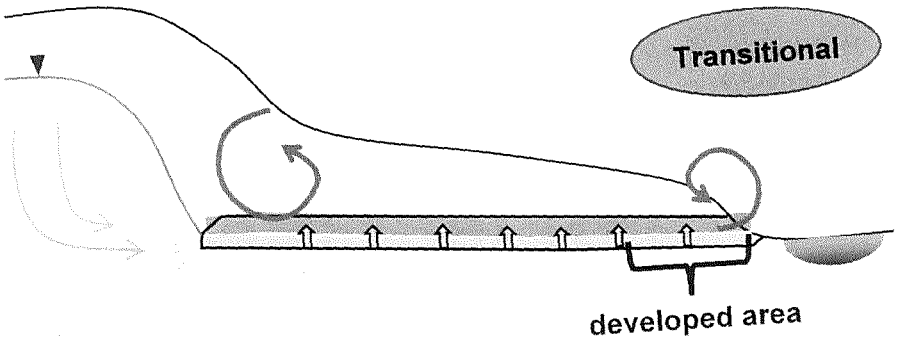

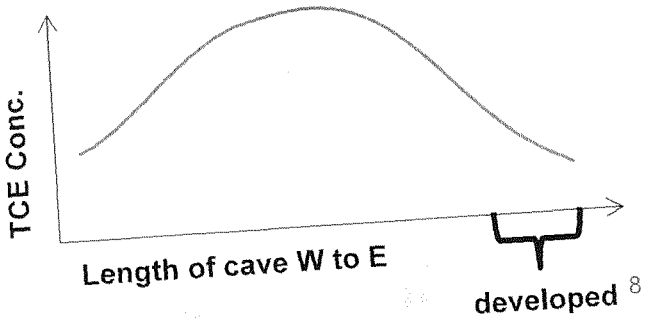

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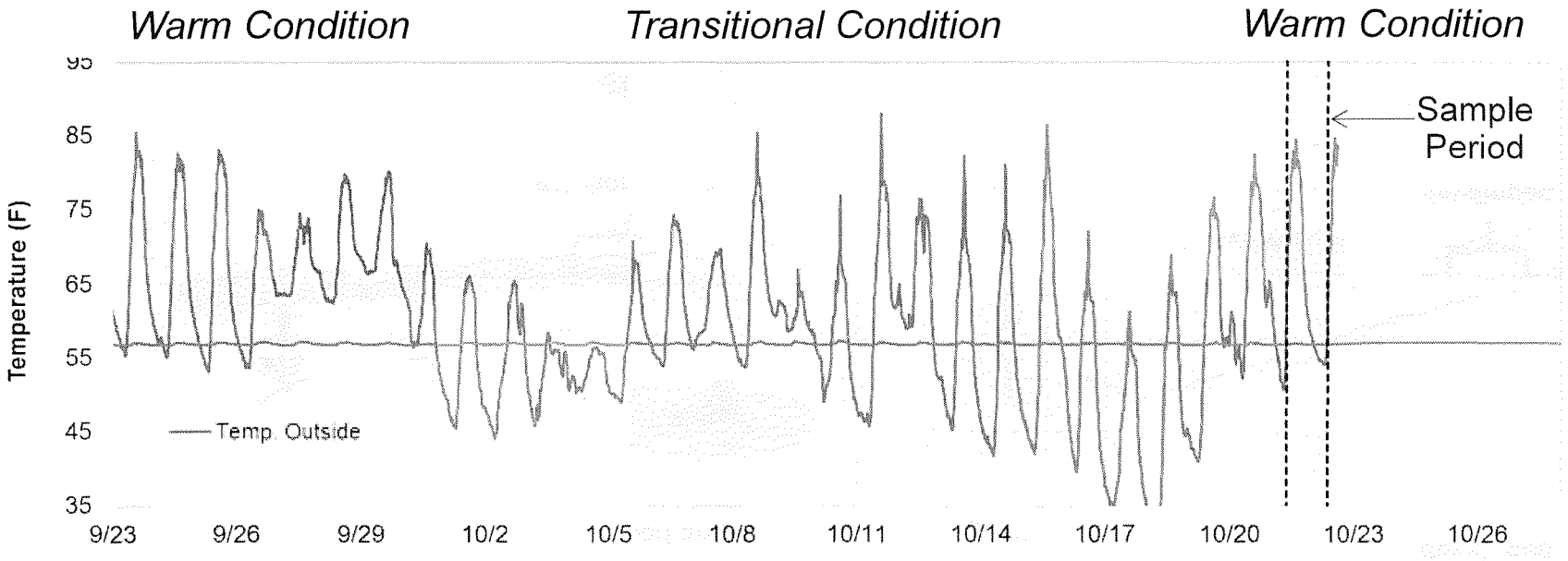
October Transitional Period



- Consistent flow down cave
- Summer-season equilibrium

- Limited net flow in or out
- Air-exchange occurring only at mouth of cave
- Deep cave air stagnant

- Flow down cave
- Stagnant air-pulse flushing out of cave

TCE in Cave Air
2015 Sampling

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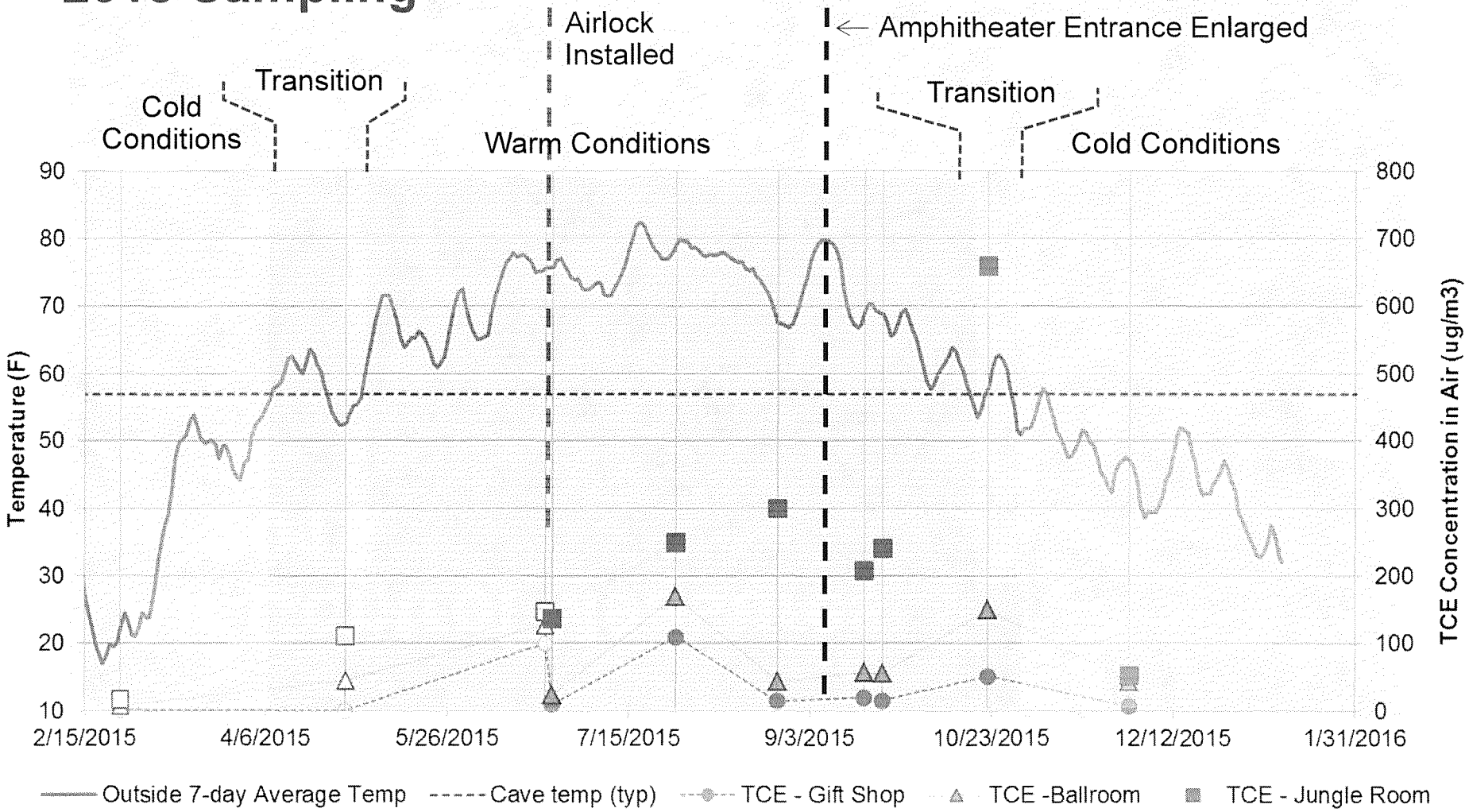

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Air Control Measures in 2015

Airlock

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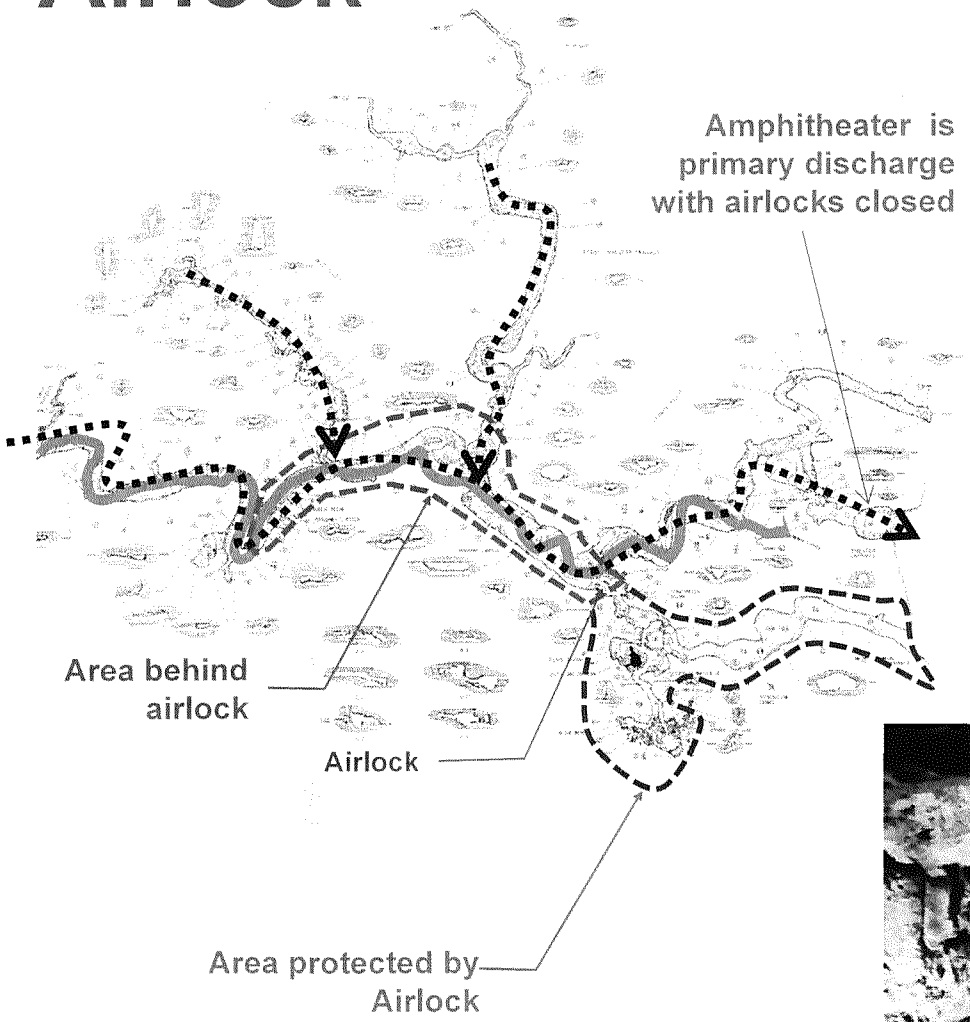
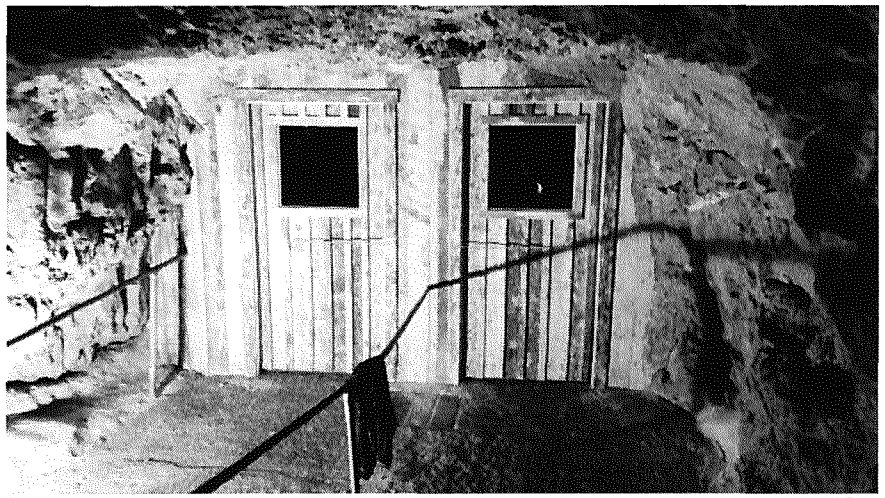


- Two sets of doors spaced approx. 100 ft apart
- Isolates portion of cave with stream from front half of toured cave
- Upgrades planned for this winter



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TCE After Air-Lock Closure

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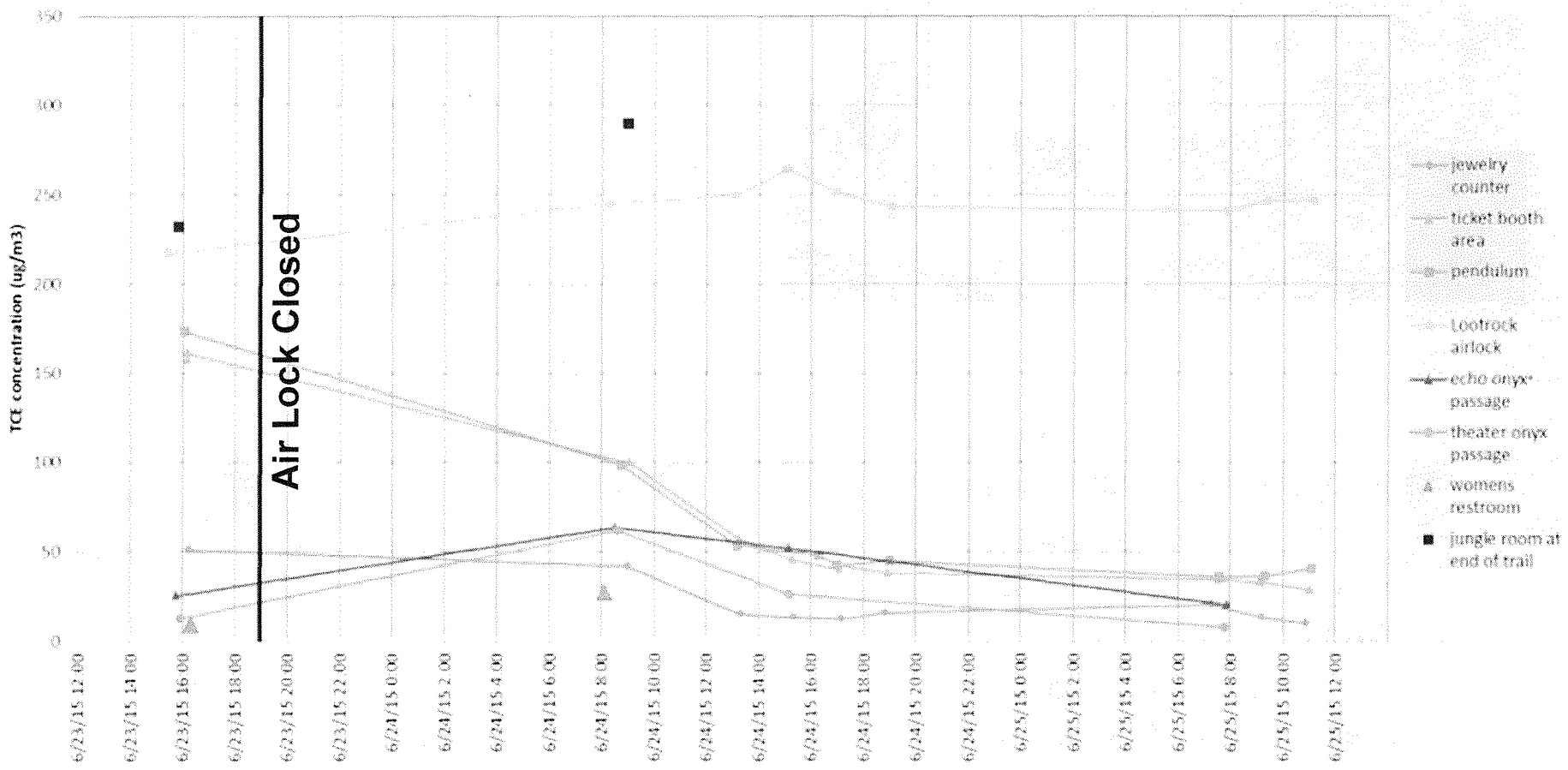

- The temporary air-lock worked as anticipated.
- Improved performance expected with additional work.

Potential Airlock Improvements

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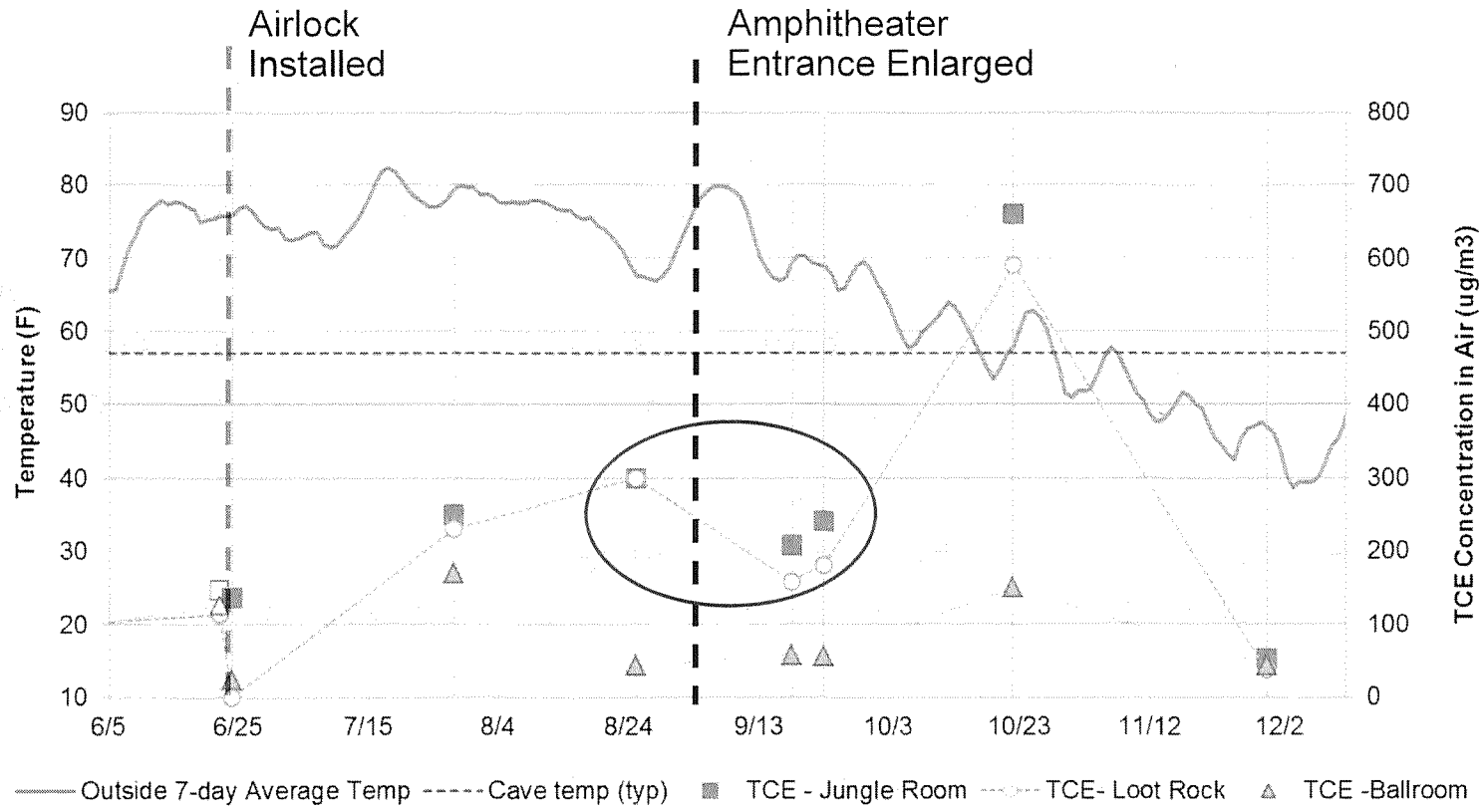
Potential Action	Likely Result
Permanently constructed doors	• Tighter closure • Fewer door "malfunctions"
Main entrance air sealing	• Reduced "draw" on air across locks • Reduce condensation, eliminating need to prop doors open in humid periods.
Develop temperature-based operation schedule	• Provide clear instructions for cave on openings and closures
Additional recon for any air-bypasses	Allow air-sealing any areas where TCE may short-circuit
Allow time for back diffusion	Concentrations will continue to drop.

Amphitheater Opening



- Amphitheater openings enlarged to increase air-flow
- Opening correlates with decrease in TCE behind airlock
- As expected, no effect seen forward of airlock

Lessons Learned

- Reductions in TCE concentrations achieved and additional gains are likely obtainable
- Important to watch for unintended consequences and be prepared to adapt
- A deliberate approach has been effective
- Effective implementation depends on adjusting to changing temperature/air-flow conditions

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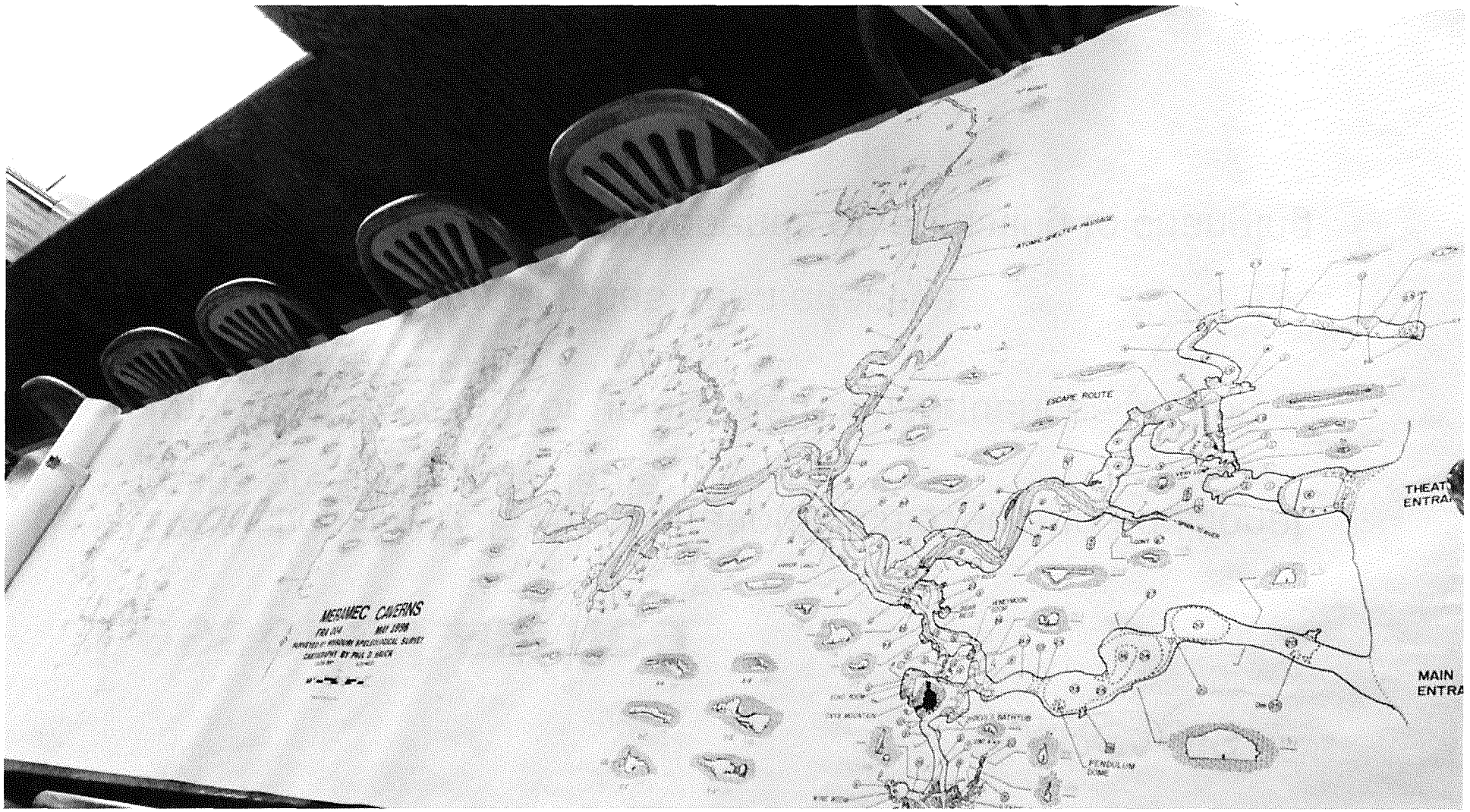

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ARCADIS Design & Consultancy for natural and built assets

TRW Automotive U.S. LLC

PHASE 2 ADDENDUM AIR CONTROLS WORK PLAN

La Jolla Spring Cave Complex
Stanton, Missouri

July 15, 2016

PHASE 2 ADDENDUM AIR CONTROLS WORK PLAN

Prepared for:

TRW Automotive U.S. LLC

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Our Ref.:

KC001590.0006

Date:

July 15, 2016

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APPENDICES

ACRONYMS AND ABBREVIATIONS

ELAP	Environmental Laboratory Approval Program
FS	Feasibility Study
HDPE	high-density polyethylene
in. Hg	inches of mercury
m/s	meters per second
MDNR	Missouri Department of Natural Resources
OUL	Ozark Underground Laboratories
PAM	personal air monitoring
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RI	remedial Investigation
SAS	Sentry Air System
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	volatile organic compound

1 INTRODUCTION

This work plan describes an additional phase of measures planned to address air quality in the La Jolla Spring Cave Complex, located in Stanton, Missouri. This plan continues a sequence of investigations and air control measures completed or still in progress starting in May 2015 and previously described in the following documents:

- Phase 1 Cave Air Work Plan (Arcadis, May 29, 2015), now referred to as the "Phase 1 Work Plan"
- Phase 2 Cave Air Work Plan (Arcadis, February 2, 2016), or "Phase 2 Work Plan"

This work plan serves as an addendum to the Phase 2 Work Plan, from which work is currently in progress.

This work is a collaborative effort of Meramec Caverns Enterprises, Inc. (Meramec Caverns) and TRW Automotive U.S. LLC, with Ozark Underground Laboratories (OUL) and Geotechnology, Inc. acting on behalf of Meramec Caverns, and Arcadis U.S., Inc. (Arcadis) acting on behalf of TRW Automotive U.S. LLC. The work is being performed as additional work under Section 28 of the Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study for the Oak Grove Village Well Superfund Site, Operable Unit 2, City of Sullivan Landfill Remedial Investigation (RI)/Feasibility Study (FS).

The original draft of this work plan was submitted February 24, 2016. Revised drafts have been submitted March 15, 2016, April 26, 2016, and July 1, 2016 in response to comments received from the United States Environmental Protection Agency (USEPA) and Missouri Department of Natural Resources (MDNR). As of this fifth submittal, substantive components of the planned work have been completed. Where appropriate, updates on the status of completed or tasks in progress are noted within the text.

2 BACKGROUND

The La Jolla Spring Cave Complex is a natural cave system in Franklin County, Missouri. Figure 1 shows the layout of the cave and its key features. A portion of the cave is privately owned and operated as a tourist attraction. As shown on Figure 2, the toured areas of the cavern have been divided into three areas: Area 1, comprising the entrance building; Area 2, comprising the developed areas of the cave between the entrance building and the airlock; and Area 3, comprising the developed areas of the cave behind the airlock. A stream flows through Area 3 from west to east, discharging to the Meramec River at La Jolla Spring. Sampling has identified the compound trichloroethene (TCE) in both the cave stream and cave air.

In consultation with the USEPA and United States Geological Survey (USGS), the cave owner undertook several measures to reduce potential employee exposure to TCE:

- Upgrades to an existing sliding-door enclosure to the gift shop and cafeteria areas, including an air curtain (initially installed for radon mitigation)
- Increasing the proportion of outside air drawn into the heating and air conditioning system serving the gift shop and cafeteria areas
- Adjustments to workplace practices, including moving break areas outside of the cave.

Starting in April 2015, Arcadis began working collaboratively with the Meramec Caverns, the USGS, USEPA, and the MDNR to conduct a phased series of air control and air monitoring programs, as described below.

2.1 Phase 1 Air-Control Program

The Phase 1 Cave Air Work Plan (Arcadis 2015) contained plans for testing two potential air control measures. The proposed measures included:

- An air barrier (or air dam), which would have been located upstream of the Jungle Room, to limit the flow of air from deeper in the cave. After further study, this concept was abandoned out of concern that the cave's frequent flooding would pose major design and operational challenges.
- An airlock, located in the "Dip" area of the cave, to isolate the front area of the cave (including the entrance building) from air carried from deeper in the cave. The airlock was constructed in June 2015 as a temporary structure that would allow testing and, if effective, provide interim air control until a permanent structure could be constructed.

As an additional measure, the cave owner reconfigured the Amphitheater area of the cave to remove obstructions to air flow and increase air circulation through the portion of the cave west (up-cave) of the airlock. This work was completed in September 2015. Periodic air sampling and related investigations were completed throughout 2015 to evaluate performance of the air control measures and improve understanding of air transport patterns.

2.2 Phase 2 Air Control Program

On February 2, 2016, Arcadis, after consultation with OUL, submitted a work plan to implement a second phase of air control measures (Arcadis 2016). This work plan entailed enhancements to the interim measures completed in 2015 and additional sampling and data collection tasks to assess and optimize performance of those measures. The scope of work included the following four components:

- Construct a permanent airlock in the Dip area, replacing the temporary structure constructed in 2015. This task is intended to provide a physical barrier to air flow between the front areas of the cave (e.g., Gift Shop and Ballroom) and deeper portions of the cave, both for control of TCE concentrations and to limit adverse condensation near the main entrance. (Condensation occurs when warm and moist summer air enters the cave and chills below its dew point.) The design will include a system of lights to notify tour guides when one of the doors is open so that unintentional opening of both doors can be avoided. Note that this Phase 2 Addendum Work Plan includes additional provisions for a magnetic interlock system to prevent simultaneous door openings and a data logging system to track when the airlock is open and closed.
- Upgrade air sealing and ventilation control at the main entrance. This task is intended to reduce adverse condensation near the main entrance.
- Amphitheater entrance ventilation control. This task entails evaluation and reconstruction of the Amphitheater entrance, a significant natural ventilation point for the cave. Several approaches are being considered. Preliminary plans involve replacement of existing doors and windows and reconstruction of the walls so that air flow in and out of the Amphitheater can be controlled. Design will be finalized after a ventilation analysis by C&R Mechanical Company, on behalf of Geotechnology.
- Additional investigations of potential air bypasses that will enhance air flow and improve air flow control in the front of the cave. These tasks are intended to support and optimize the other planned air control tasks.

The Phase 2 air control tasks were completed in the spring of 2016, with the exception of Amphitheater reconstruction, which is nearing completion as of this submittal date. As described below, the Phase 2 Addendum work will build upon the prior phases of work.

3 OBJECTIVES

The scope of work described in this work plan is intended as a continuation of the Phase 1 and Phase 2 air control efforts undertaken since 2015. The primary Phase 2 Addendum objectives are to:

- Further reduce TCE concentrations in cave air in both the entrance and rear portions of the toured cave.
- Limit unintended consequences of altered cave ventilation patterns, including increased condensation and mold growth.
- Conduct a pilot test to evaluate the effectiveness of operating a vent fan through one or more boreholes to be installed near the rear of the cave.
- Minimize the use of cave stream water to mitigate the potential volatilization of TCE in cave spring water used for wash water and other purposes during cave operations.
- Collect samples to assess the effectiveness of Phase 2 and Phase 2 Addendum air control measures.
- Conduct a treatability study to test the viability of portable air cleaners (Sentry Air Systems) in lowering TCE concentrations in the cave environment.

4 SCOPE OF WORK

The Phase 2 Addendum scope of work includes the following components:

- Prepare a Quality Assurance Project Plan (QAPP) to guide the data collection and quality.
- Complete air sampling and data acquisition through a combination of three programs:
  - Routine monitoring, to track TCE concentrations in air at a network of fixed locations within the cavern. Routine monitoring also includes climate and air flow monitoring and limited cave stream water sampling.
  - Compliance personal air monitoring (PAM) will be conducted to demonstrate that the cave may be opened for tours.
  - System optimization monitoring will be implemented on a task-specific track to assess and optimize performance of the air control measures.
- Complete a series of additional air controls measures, including:
  - Evaluate the existing Gift Shop heating, ventilation, and air conditioning (HVAC) system to determine if modifications are necessary to achieve USEPA's level of health concern in the Gift Shop.
  - Install a new wash-water line using well water to replace the existing water system inside the cave that used cave stream water or develop an alternative walkway cleaning process that does not use cave stream water.
  - Construct and test a borehole ventilation system upstream of the Jungle Room.
  - Install an air barrier to limit transport of air from the Atomic Shelter Passage to the main trunk of the cave, if needed, after the borehole vent is operational.
  - Conduct a treatability test on the viability of using portable air cleaners (Sentry Air Systems) to reduce TCE levels within the cave.
  - Install an airlock door interlocking system and a data logger to monitor door use.

The sampling, data collection, and air control activities are presented in detail in the following sections.

Additional tasks relating to the air-controls program will be included as part of the Post-Removal Site Control Work Plan, planned for submittal to USEPA and MDNR on November 1, 2016. The plan is anticipated to include continued monitoring, operations-and-maintenance of air-controls, and contingency plans. In addition, the plan will also consider whether reasonable and appropriate monitoring should be implemented to objectively track potential adverse secondary effects (i.e., condensation, mold-growth, and changes to cave features) caused by implementation of the air-controls. If adverse secondary effects from the air controls are observed, operation of air-controls will aim to limit the adverse secondary effects caused by the air-controls to the degree feasible, while maintaining TCE concentrations in the cave-air below USEPA's levels of health concern.

5 QUALITY ASSURANCE PROJECT PLAN

A QAPP will be prepared and submitted to USEPA for review and approval prior to implementing the sampling program described in this work plan.

The QAPP will be prepared consistent with USEPA guidance (USEPA 2002) for conducting Remedial Investigation/Feasibility Studies activities. The QAPP will include a description of the quality assurance/quality control (QA/QC) protocols that will be used to achieve the desired data quality objectives. The QAPP will specify the analytical methods to be used during the sampling program.

The draft QAPP was submitted to USEPA and MDNR on April 1, 2016. Comments were received from the USEPA, April 21 2016. A revised draft QAPP was submitted to USEPA and MDNR on May 6, 2016. Additional comments were received from the USEPA on May 20, 2016. A final QAPP was submitted June 17, 2016, revised July 11, 2016.

6 ADAPTIVE COMPLIANCE AND ROUTINE MONITORING

This work plan describes a plan for compliance and routine monitoring that is intended remain adaptive to changing data needs as the air controls are implemented, portions of the cavern are reopened, and effectiveness of the air controls becomes better understood. This planned flexibility includes probable changes to the number of samples and the frequency of their collection. Note that this plan encompasses the remaining 2016 calendar year only. Plans for additional monitoring after 2016 will be included as part of the Post-Removal Site Control Work Plan, planned for submittal to USEPA and MDNR on November 1, 2016.

6.1 Sampling Frequency

Sample event frequency is planned to be highest during initial trial periods before and immediately following cave reopening, then gradually reduced over the 6-month course of the program, contingent on compliance monitoring results that are consistently below USEPA's stated 6 micrograms per cubic meter (µg/m^3) TCE level of concern, averaged over an 8.5-hour exposure period. Assuming that all compliance results were consistently below the level of health concern, the sampling schedule would be as follows:

Anticipated Sampling Frequency and Laboratory Turnaround Times if PAM samples remain under 6 µg/m^3

	Pre-Opening Trial Period	Post-Opening Trial Period	Next Two Months	Remainder of 2016
Compliance Monitoring (PAM samples)	• Minimum of 3 events over 2-week period • 3-day turnaround	• Weekly for 4 weeks • 3-day turnaround	• Every 2 weeks • 3-day turnaround	• Monthly • 3-day turnaround
Routine Monitoring (all fixed-location samples)	• Weekly events • 5-day turnaround	• Weekly for 4 weeks • 5-day turnaround	• Every 2 weeks • 10-day turnaround	• Monthly • 10-day turnaround

Each step down in sample frequency will be contingent on sample results and agreement of the USEPA that the conditions can be maintained. Other information, such as airflow, cave climate, vent-well system performance data, and significant changes in mitigation measures and systems will be considered in recommendations to adjust the sample frequency.

If a PAM result exceeds 6 µg/m^3 after the cavern has reopened, the sample frequency will immediately revert to weekly, and the reason for the exceedance will be evaluated. Resampling will occur as soon as possible, with results to be received no more than 7 days after the initial exceedance was reported by the laboratory. If subsequent samples are below the level of concern, sampling will continue weekly for a total of 4 weeks, or until the most appropriate frequency for continued monitoring is agreed upon, based on the most probable explanation of the exceedance.

If PAM results exceed 6 µg/m^3 for 3 consecutive weeks, then USEPA and other stakeholders will choose the most appropriate response. Potential responses include adjusting tour duration or the allowable number of tours, or closing part or all of the cave to public tours.

Additional air sampling may be completed if conditions arise that elevate uncertainty about air-quality in the caverns; in particular:

- A significant change in operation of an air-control measure
- A change in business operations that may alter the amount of time tour guides spend in the caverns
- Seasonal variability

The need for, and specific scope of additional sampling, in each of these cases, will be determined via discussion with EPA and MDNR as those conditions occur, based on the understanding of cave conditions at that time. Additional sampling may involve a short-term increased frequency of the regular monitoring program, or more targeted sampling in select locations to efficiently demonstrate that no adverse changes have resulted from a changed condition.

6.2 Adaptive Compliance Sampling Scope

The number of compliance samples collected per event and the cave worker workday scenario tested will also be adaptable.

PAM samples will be collected in replicate during the initial trial periods in order to understand sampling variability and provide a solid basis to resume tours. Once the initial trial periods are complete, and detected concentrations of TCE in all PAM samples have been shown to remain below the level of health concern, the number of samples will be reduced to one per event, as shown in following table.

Anticipated Numbers of Sample Collected for Compliance Monitoring

	Pre-Opening Trial Period	Post- Opening Trial Period	After Trial Period
Compliance Monitoring (PAM samples)	Two PAM samples per event carried on simulated tours	Two PAM samples per event carried following two separate guides, selected randomly	One PAM sample per event following one guide, selected randomly

In the "after-trial-period" phase of sampling, Arcadis will be prepared to repeat PAM sampling within 3 days if an equipment or shipment problem renders the PAM sample unusable.

The schedule of tours to be tested by the PAM samples will also vary depending on the status of the cave reopening, as follows:

	Worker Schedule Tested
Front of Cave Open (Areas 1 and 2)	• 8.5-hour day • 4 or 5 tours (see explanation below) • Non-tour time in Entry Building
Full Cave Open (Areas 1, 2 and 3)	• 8.5-hour day • 3 or 4 tours (see explanation below) • Non-tour time in Entry Building

The majority of front-of-cave PAM samples will be completed as 4-tour workdays, representative of the current normal practice by tour guides. To understand exposure under the 5-tour workday, Arcadis will collect one 5-tour sample, every-other event, by substituting one of the two PAM samples for a 5-tour simulation. Note that when the full-cave has opened, front-of-cave PAM sampling will be discontinued.

PAM samples of the full-cave will initially be tested as 3-tour workdays, consistent with normal practice by tour guides. When the full-cave has reopened and sampling results indicate that testing a 4-tour/full-cave workday is likely to be successful, testing of a 4-tour-workday will be included in the program.

If the need to test alternative worker scenarios arises, the testing plan will be discussed with stakeholders before being implemented.

6.3 Adaptive Routine Sampling Scope

As described in Section 7, the routine monitoring program includes "regular" events, following the frequency described above, with less frequent "expanded" events, which include a wider suite of monitoring tasks. All routine monitoring events will include a fixed set of five primary stationary samples to provide continuity and consistency for purposes of tracking air control performance. Provisions will also be made to collect supplemental stationary samples based on current data needs. Two to four supplemental samples (or "floaters") will be allocated to each routine monitoring event, as indicated in the table below.

Anticipated Samples for Routine Monitoring

	Primary Stationary Sample Locations	Potential Supplemental Samples
Regular Sampling Event	Gift shop Ballroom Theater Loot Rock Jungle Room	Two "floater" locations to be determined based on current data needs
Bi-Monthly Expanded Sampling Events	Same as regular event	Four "floater" locations

Potential supplemental "floater" locations may include Cafeteria, Ticket Counter, Honeymoon Room, Echo Room, Airlock, Lassie Room, Atomic Shelter Passage, Mud Alley, Amphitheater Entrance, or others, if needed. Not all locations are anticipated to be sampled. **Table 1** describes the specific sample locations. Locations are also shown on **Figure 2**.

7 COMPLIANCE PERSONAL AIR MONITORING PROGRAM

PAM samples will be collected to demonstrate that air quality meets the criteria to resume or continue normal operations. This section describes the methodology that will be followed. The timing and frequency of samples and evaluation criteria were discussed in Section 6.

The approach to collecting personal air monitoring samples will be as follows:

- Samples will be collected via 6-liter evacuated stainless steel canisters (Summa canisters). Canisters will be individually certified clean and used only if received from the laboratory with a vacuum of at least -25 inches of mercury (in. Hg).
- Canisters will be obtained with laboratory-supplied vacuum gauges and flow controllers pre-set for collecting a sample over an 8.5-hour time period (i.e., the standard duration of a tour guide's shift, including lunch break).
- The canister will be placed in a backpack, with the intake protruding at least 3 inches outside of the zipped volume of the bag.
- Sampling activities will be either performed by or with supervision by an Arcadis employee present at the caverns during sampling. Cave employees may be used to carry backpack samplers on simulated or actual tour guide workdays; however, an Arcadis team member will be responsible for handling canisters and regulators, keeping notes and records, and providing guidance for appropriate conduct of backpack carriers during sampling. Cave employees assisting with sampling will be asked to keep notes of times in areas specific areas of the cavern.
- As described in Section 6, samples will collected to represent a tour guide's typical 8.5-hour day, either as a simulated tour or by following actual tours in progress.
- The sampler will carry the backpack for the full period of time spent in the cave, outside of the Entry Building. For the period of time spent within the Entry Building, the backpack may be taken off and placed in an open area within the Gift Shop. Based on direction from USEPA, the full 8.5 hour sample period will be collected within the cavern or the entry building, with no time spent outside, though actual tour guides typically spend some portion of their break time outdoors, weather permitting.
- The sampler will keep a log of times spent in: 1) the entry building, 2) the area between the entry building and the airlock, and 3) the area behind the airlock.
- As described in the QAPP, backpack blank samples will be collected for three consecutive events when new backpacks are used. A backpack blank will be collected by deploying an 8.5-hour regulated canister in an identical backpack, placed at the outdoor air location (see **Table 1** for description). Replicate samples (i.e., additional PAM samples collected on the same workday) will be collected as described in Section 6.
- At the end of the simulated workday, the canister will be removed from the backpack, sealed, and labeled with the sample identification number. The sample will be shipped via overnight carrier to TestAmerica for analysis of TCE via USEPA Method TO-15.

8 ROUTINE MONITORING PROGRAM

Sampling locations, frequency, and number of samples are as described in Section 6. **Figure 2** identifies sample locations.

8.1 Routine Air Sampling

Air samples for volatile organic compound (VOC) analysis will be collected on a recurring schedule as described in Section 6. Additional locations will be included during bi-monthly expanded monitoring events, tentatively scheduled for the last routine events of July, September, and November, 2016.

Samples will be collected via 6-liter evacuated stainless steel canisters (Summa canisters), following the procedures in Appendix A. Canisters will be obtained from TestAmerica, Inc., an Environmental Laboratory Approval Program (ELAP) certified laboratory. Canisters for routine monitoring will be batch-certified clean and used only if received from the laboratory with a vacuum of at least -25 in. Hg. Note that individually certified clean canisters will be used for compliance monitoring samples (described under separate cover), but not routine monitoring samples, which are not intended for demonstrating attainment of a regulatory standard.

Canisters will be obtained with laboratory-supplied vacuum gauges and flow controllers. Flow controllers will be pre-calibrated by the laboratory to allow sample collection over a complete 8.5-hour time period.

Samples will be deployed in the cavern for an 8.5-hr period spanning a typical workday. Samples will be drawn from the approximate breathing height (3 to 5 feet above ground) of a site worker. Quality control samples will be collected at the frequency indicated in the QAPP. Once each canister is full (i.e., -5 in. Hg remaining, as measured by a pressure gauge or sample period has elapsed), it will be sealed and labeled with the sample identification number. Samples will be shipped via overnight carrier to the analytical laboratory for analysis of chlorinated VOCs via USEPA Method TO-15.

8.2 Cave Stream Sampling

Surface water samples will be collected at two cave spring locations concurrent with expanded bi-monthly routine air monitoring events, as described above. Samples will be collected in the primary cave stream adjacent to the following locations (shown on Figure 2):

- Jungle Room
- Above the falls near Loot Rock.

Surface water samples will be collected as direct grab samples from the approximate center of the cave stream. Due to health and safety concerns, samples will be collected with an extendable rod from the stream bank rather than by wading. The sample collection methodology will be as follows

1. Samples will be collected in order from downstream to upstream.
2. Samples will be collected directly into a pre-cleaned baked-glass container near the mid-point (vertically) of the water column.

3. The sample collection container will be immersed at an angle such that water gently flows in with minimal disturbance.

4. The sample water will then be carefully transferred into a laboratory-certified pre-preserved container.

5. After the sample has been collected, an additional aliquot of stream water will be grabbed for measurement of temperature and specific conductance using a calibrated field meter (e.g., Oakton PC450, or similar).

The surface water samples will be analyzed for VOCs by USEPA method 8260B. Quality control samples will be collected as indicated in the QAPP.

8.3 Cave Stream Discharge Measurement

Stream discharge of the cave stream will be gauged as a component of each expanded bi-monthly monitoring event. Gauging will be performed after surface water sampling is complete to minimize potential interference with samples. Gauging will be completed by the velocity-area method, on a cross-sectional transect of the cave stream at the first bridge upstream of Loot Rock, as shown on **Figure 2**.

At the cave stream discharge measurement location, the flow will be measured using the velocity-area method, using a flowmeter to measure the average current velocity at regular intervals across a perpendicular transect of the stream. The meter used, a Marsh-McBirney Flo-Mate Model 2000 portable electromagnetic flowmeter, was approved by USGS field personnel.

The methodology is as follows:

1. Measurements of stream velocity are collected with portable electromagnetic flowmeter (e.g., Marsh-McBirney Flo-Mate Model 2000, or similar) mounted on a graduated rod.

2. Measurements are completed at 1-foot intervals, demarked with a measuring tape, crossing the cave stream on the upstream side of the bridge.

3. At each measurement point, the stream depth is gauged.

4. If the stream depth is less than or equal to 2.5 feet (expected condition), the average stream velocity is measured estimated based on the 0.6 depth method (e.g., if the depth is 1 foot, the velocity measurement will be collected 0.6 foot below the water surface).

5. If the stream depth is greater than 2.5 feet, the two-point method is used. The two-point method consists of measuring the velocity at 0.2 (20%) and 0.8 (80%) of the depth from the water surface, and using the average of the two measurements.

6. The total discharge will be calculated as the sum of the flows in each 1-foot segment of the transect, calculated as average velocity multiplied by the depth and width of the segment.

8.4 Continuous Climate Monitoring

A continuous climate data monitoring station will be established approximately 100 feet downstream of the Jungle Room (i.e., at the current USGS anemometer station). The station will record the following:

- Air temperature
- Relative humidity
- Air velocity
- Air flow direction.

Measurements will be recorded every 5 minutes. The station will be designed and placed in coordination with the USGS in order to maintain, to the extent feasible, continuity of data with the existing monitoring station. The station will include a WindSonic 2D anemometer, designed to monitor air velocity and direction at low speeds. Instruments specifications for the anemometer and other sensors are included in Appendix B.

A separate temperature and relative humidity monitoring station will be established outside the cave, in a location shaded from direct sunlight.

Data from both monitoring stations will be downloaded during each air sampling event, or as needed to support other activities.

8.5 Differential Pressure Measurement

During each routine monitoring event (regular and expanded), the differential air pressure will be measured across the airlocks. This measurement will help gauge whether the airlock seal remains tight, and whether the air pressure gradient is directed up-cave, as expected when the vent-well system is in operation.

Differential pressure is measured using a handheld manometer. Two ports were constructed into the airlocks for measuring:

1. Differential pressure across the Ballroom-side airlock door
2. Differential pressure across the entire airlock, via tubing extending from the Ballroom-side airlock door to the Loot Rock-side airlock door.

The tubing extending through each port is capped. Before collecting the measurements, the caps will be removed, and the airlock doors will remain closed for at least 10 minutes to allow equilibration. Both measurements are recorded from the Ballroom-side airlock door. Caps will be replaced after taking a reading.

8.6 Manual Air Flow Measurement

Cross-sectional manual airflow measurements will be completed at two locations in the cavern:

- At the permanent anemometer station near the Jungle Room, a location previously established by the USGS as appropriate for estimating the total airflow through the main stem of the cavern entering or exiting the developed areas
- At a location referred to as the Theater Tunnel, a passage connecting the upper level rooms (Theater and Wine Room) with the lower level rooms (Ballroom). Measurements at this location are expected to gauge the majority of airflow moving between the Wine Room vents and the main entrance.

Air flow measurement locations are shown on **Figure 2**. Manual air flow measurements will be recorded at the Jungle Room monitoring station at least twice during the reopening period for the area of the cave behind the airlock, and then as a component of each expanded routine monitoring event. These data will provide a quality check of the continuously logging anemometer and improve estimation of volumetric airflow rates based on the linear-velocity anemometer measurements. Airflow at the Theater Tunnel will be measured during each expanded routine monitoring event.

Note that accurate air flow measurements are challenging to obtain in the cave, where most passages are irregularly shaped, and air velocities are often barely measurable. Air velocities also oscillate continually as outside air temperatures change and, to a lesser degree, when temperatures are stable (e.g., as a function of wind-driven pressure differentials). Few locations in the cave are suitable for collecting reliable cross-sectional air flow measurements. The cave profiles at the Jungle Room monitoring station and Theater Tunnel have been interpreted to be the most suitable locations for air flow measurement. The cave passages are relatively straight and narrow, and all parts of the cross-section are accessible with a handheld anemometer.

Additional air flow and point-velocity measurements may be collected at other locations in the cave as needed to support performance monitoring, but will not be a component of routine monitoring.

Because air velocities are known to oscillate in response to the outside air temperature changes, air flow will be monitored only during a period of the day when outdoor temperatures are anticipated to be stable (e.g., not expected to vary by greater than 4 degrees Fahrenheit within a 1-hour period). Measurements will be conducted as follows:

1. If the cross-section dimensions are not already known, measurements will be taken to estimate the cross-sectional area of the transect. Note that the Jungle Room station cross-section has been established to be 13 square meters (140 square feet).

2. Individual air velocity measurements will be taken on a grid of approximately equal-area cells encompassing the entire cross-section. Where the USGS has previously established a measurement grid (e.g., at both Jungle Room and Theater Tunnel), Arcadis will collect measurements at those grid points. If a new grid is to be established, the nominal target grid size will be 2.5 feet high by 2.5 feet wide (6.25 square feet). For example, the 140-square-foot cross-sectional area at the Jungle Room will be subdivided into approximately 22 equal area cells. If a high degree of variability is noted, the grid may be refined. This frequency is consistent with prior measurements completed by the USGS.

3. A measuring tape and measured rod will be used to locate the approximate lateral and vertical position of each measurement.

4. Air velocity will be measured using a hot-wire anemometer with omnidirectional probe with a resolution of 0.01 meter per second (m/s; 2 feet per minute). The anemometer will be held upwind, in the approximate center of each grid cell. If it becomes difficult to obtain a stable value, a tripod or similar anchoring device may be used. Readings will be recorded as follows:

    a. After the anemometer has been moved to a measurement point, it will be held steady until stable airflow is re-establish (until measurements vary no greater than ± 15%, or up to one minute)

    b. After equilibration, the maximum, minimum, and average velocity will be recorded over an additional approximate 15-second period.

5. To test whether airflow conditions changed significantly during the period of measurement, two or more measurements collected at the start of the transect will be repeated after the full transect has been completed.

6. Total air flow in the transect will be computed as the average velocity of each equal area cell times the total cross-sectional area. If non-uniform cells are used, the average velocity will be weighted to the cell size.

Note that temperature, relative humidity, wind velocity, and wind direction will be recorded continuously at the Jungle Room climate station adjacent to the measured transect. If air flow is measured in other areas of the cave, temperature and relative humidity measurements will be recorded at a minimum of four locations within the cross-section to test for stratification. If air flow direction is not immediately apparent, it will be visually noted based on drift of a small puff of smoke.

9 PHASE 2 ADDENDUM AIR CONTROLS

Several temporary air controls were proposed for implementation in the Phase 2 Cave Air Work Plan (Arcadis 2016). The following sections describe additional air controls that will be implemented to improve cave air quality.

9.1 HVAC Evaluation

C&R Mechanical Company will evaluate the existing HVAC system in the Gift Shop to determine if modifications are necessary to achieve USEPA's level of health concern in the building. The air conditioning system and configuration of the glass door separating the Gift Shop from the cave will be the focus of the evaluation.

The work described in the section was completed prior to this submittal date, consistent with earlier drafts of this work plan. Based on air sampling results completed as of this submittal, implementation of other air controls (e.g., airlock) have reduced TCE concentrations in the Gift Shop to below USEPA's level of health concern without modification of the entrance building HVAC system. The HVAC evaluation will be submitted by November 1, 2016.

9.2 Wash Water Line

Portions of the cave path, stairs, and the Theater Room curtain wall are sprayed by Meramec Caverns employees with cave stream water to clean and to enhance visual appeal. The source of the water was the cave stream, which has historically contained low levels of TCE.

As of this submittal date, Meramec Caverns has evaluated multiple potential approaches for replacing the caverns wash-water source. Due to significant logistical challenges, the Cavern may not be able to install a water line into the cave and therefore, is currently using a system of hoses to provide clean well water to serve the area of the cavern in front of the airlocks including the Theater Room curtain. Additional measures will be evaluated in consultation with USEPA and MDNR.

9.3 Install Vent Well System

Two ventilation wells will be installed on the main trunk of the cave system upstream of the Jungle Room. The vent wells will be outfitted with a fan at the ground surface designed to withdraw air from the cave. It is anticipated that the fan or blower will be operated under transitional and hot weather conditions, when natural flow patterns would be directed down-cave. The purpose of the system is to capture and vent air that has migrated down-cave before it reaches the developed portion of the cave. The vent-well system should also draw in air from down-cave of its location, reversing the normal summer flow conditions and drawing in fresh outside air from lower-level entrances such as the Amphitheater.

The vent-well construction task will include the following general activities:

- A survey will be conducted to fix several potential borehole locations, both inside the cave and on the hillside above it. Locations will be within appropriately 200 feet of Jungle Room on the main trunk of the cave. Final selection of locations will be based on a combination of rig accessibility and cave roof

integrity at that location. Note, this task was accomplished while this work plan was in draft form. The selected drilling locations are shown on Figure 2.

- The existing logging road will be improved, and additional roads will be cut to allow access for a drilling rig and support equipment. Note, this task was accomplished while this work plan was in draft form.
- Each bedrock borehole will be drilled to intersect the cave. The approximate depth to the cave from the drilling pad is 220 feet.
- An all-weather, industrial ventilation fan or blower will be installed and connected to the vent opening.
- A power feed will be brought to the borehole site. A generator may be used for an interim power supply, if needed.
- A separate make-up air system will be installed in the Amphitheater entrance and pilot-tested to evaluate its potential to be use in concert with borehole ventilation system by blowing outside air into the cave from the Amphitheater entrance. The pilot ventilation system will be integrated into reconstruction of the Amphitheater entrance (a component of the Phase 2 Work Plan).

After installation, the borehole ventilation system will be tested to determine the extraction rates required to capture down cave air flow and draw fresh air from the cave entrances under a range of outside temperatures. The test will also evaluate how system operation alters the cave climate. Testing will include the following types of data collection:

- Measurements of the vent-well system total extracted airflow rate
- Continuous logging of air velocity and direction, temperature, and relative humidity at the fixed-based anemometer (described in Section 6.3)
- Continuous logging of temperature and relative humidity at an additional four locations in the cave, (anticipated to include the Amphitheater, Loot Rock, Lassie Room, and between the airlocks) and at the outdoor climate station
- Manual anemometer and/or flow direction measurements at selected points to evaluate changes under varying ventilation rates. These points include the Amphitheater Entrance, the main passage at the first bridge upstream of Loot Rock, the Atomic Shelter Passage before the tee, and the mouth of Mud Alley.
- Differential air pressure measurements across the airlocks
- Air samples for VOC analysis using 8-hour stationary canisters, following the protocol described in Section 6.1. Locations will be determined based on observed cave airflow patterns, and will be used to determine:
    - Air quality of key sample locations (e.g., Loot Rock and Jungle Room) under tested ventilation rates
    - Air quality of tributary passages, such as Mud Alley and the Atomic Shelter Passage.

After initial system diagnostics and baseline data collection, the vent-well system will be operated over a series of stepped rates.

The work described in the section was completed prior to this submittal date, consistent with earlier drafts of this work plan. Initial pilot-testing of a temporary blower system began May 24, 2016. An interim skid mounted vent well blower system was installed on May 24, 2016. The long-term vent-well system and treatment building became operational June 16, 2016.

9.4 Atomic Shelter Passage Air Barrier

Sampling data have shown that the Atomic Shelter Passage conveys air into the toured parts of the cave. If needed, a wall and airtight doorway will be installed in a constricted section of the Atomic Shelter Passage to eliminate this potential transport pathway. This area is not known to flood, and is outside the toured part of the cave; therefore, the design may be simple in order to be effective. The wall and door will be constructed of plastic to limit mold growth and swelling. The need to install the air barrier in the Atomic Shelter Passage will be determined after the borehole vent system has been pilot tested and is fully operational for 4 weeks. If the Atomic Shelter Passage is still determined to be an uncontrolled TCE transport pathway, the air barrier will be installed.

9.5 Treatability Study of Portable Air Cleaners

Geotechnology is implementing the use of portable air cleaners as an interim measure to assist with concentration reductions in the Restaurant, Gift Shop, Ballroom, and Theater. The air cleaners have limited capabilities for treating large-volume air spaces and are not viewed as a stand-alone long-term remedial solution. Five Sentry Air Systems (SAS) portable air cleaners (Model #SS-450-PRAC includes activated carbon filter and pre-filter) were placed into full-time operation (24/7) in the referenced areas on March 22, 2016. The placement of the air cleaners will be adjusted based on air testing results. The treatability testing is planned to last 8 weeks, and additional ongoing use will be evaluated.

Air testing results collected during the air cleaner testing period will be compared to the historical data to determine the relative effectiveness of the portable air cleaners. To date, it appears that, in the smaller operating spaces such as the Gift Shop, Restaurant, and Theater, the air cleaners have assisted with concentration reductions. With the airlock door replacements and related improvements, we anticipate that concentrations will decrease in the Ballroom.

Operational issues will be documented by Geotechnology. In the referenced areas, to date, the operation of the portable air cleaners has not been negatively affected by humidity levels in the cavern.

A spreadsheet showing theoretical breakthrough calculations for the activated carbon was provided to USEPA and MDNR on April 6, 2016. The spreadsheet indicates the general operating specifications of the air cleaners. A conservative approach will be used so that the activated carbon is replaced prior to breakthrough. Handling of the spent activated carbon will be based on toxicity characteristic leaching procedure (TCLP) testing of the activated carbon in each unit.

The portable air cleaners remain in operation as of this submittal date. In consultation with USEPA, one unit was moved from the Ballroom to the area between the airlock doors. Simultaneously, Arcadis has evaluated use of larger, higher capacity air-polishing units to supplement and/or replace the portable air

cleaners. A technical basis-of-design memorandum was submitted to USEPA and MDNR on May 19, 2016 describing the proposed and design and implementation of the larger units.

9.6 Airlock Door Interlock and Logging System

The major design elements for the permanent airlocks were described in the February 2, 2016 Phase 2 Work Plan. As specified in that plan, the airlock will include a signal system that indicates whether one or both air lock doors are open to avoid accidental simultaneous openings of both sets of doors. That system is anticipated to comprise red and green lights.

In addition to the signal system described in the Phase 2 Work Plan, the airlocks will include a system of magnetic interlocks that prevent simultaneous door openings, and a data logging system that will record when the doors are open and shut. The interlock system will be equipped with an emergency override as a safety feature. The override consists of buttons mounted under a plastic guard between each set of doors that deactivate the magnetic interlocks and allow both doors to open simultaneously. Note that the locking system is electromagnetic, and automatically disengages in the event of a power failure. Data from the logging system will be downloaded during each monitoring event, or as needed, to verify that airlocks are performing as planned (e.g., not stuck open), and that cave personnel are using the airlocks according to the operating instructions.

Airlock construction was completed in May 2016.

10 UPCOMING ACTIVITIES

The following Phase 2 Addendum sampling and air control construction projects have yet to be implemented, but are planned for 2016. Specifically:

- Sampling will begin in late June 2016, after the completion of currently scheduled USGS sampling. Sampling with continue through December 2016.

The dates contained in this schedule are considered good faith estimates. Any unanticipated delays or complications are not factored into the schedule.

11 NOTIFICATION AND REPORTING

Arcadis and/or the Meramec Caverns will notify USEPA and MDNR at least 1 week in advance of construction activities. USEPA will be notified when projects are complete and informed of any changes from the anticipated design. Data generated and performance observations will be shared with Meramec Caverns, USEPA, MDNR, and USGS on an ongoing basis.

12 REFERENCES

Arcadis. 2015. Cave Air Work Plan. La Jolla Spring Cave Complex. Stanton, Missouri. Arcadis. Lenexa, Kansas. May 29.

Arcadis. 2016. Phase Two Cave Air Work Plan. La Jolla Spring Cave Complex. Stanton, Missouri. Arcadis. Lenexa, Kansas. February 2.

United States Environmental Protection Agency (USEPA). 2002. Guidance for Quality Assurance Project Plans. EPA QA/G-5. United States Environmental Protection Agency. Office of Environmental Information. Washington, D.C. EPA/240/R-02/009. December.

United States Environmental Protection Agency (USEPA). 2009. Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study for the Oak Grove Village Well Superfund Site, Operable Unit 2, City of Sullivan Landfill RI/FS.

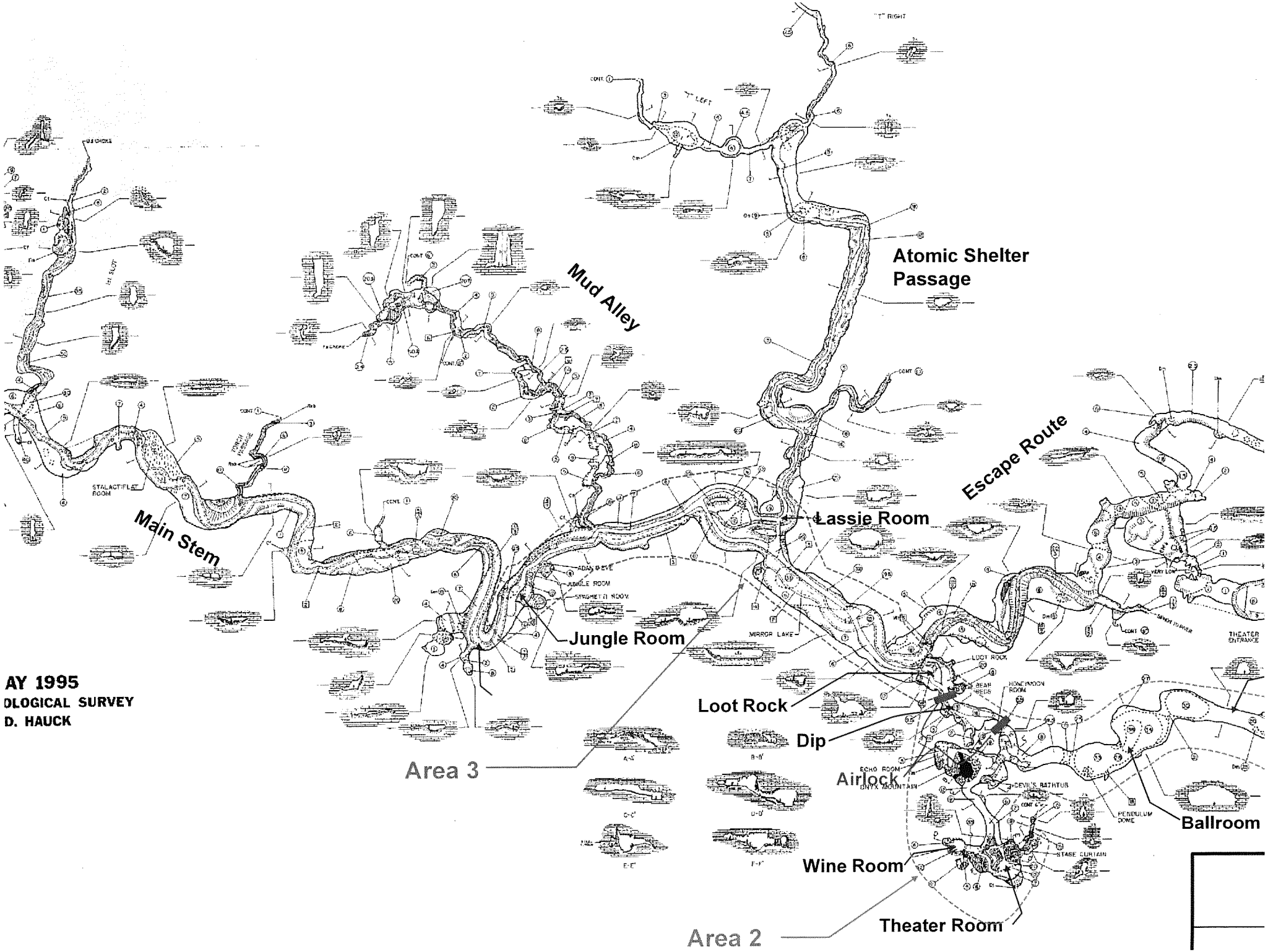
TABLES

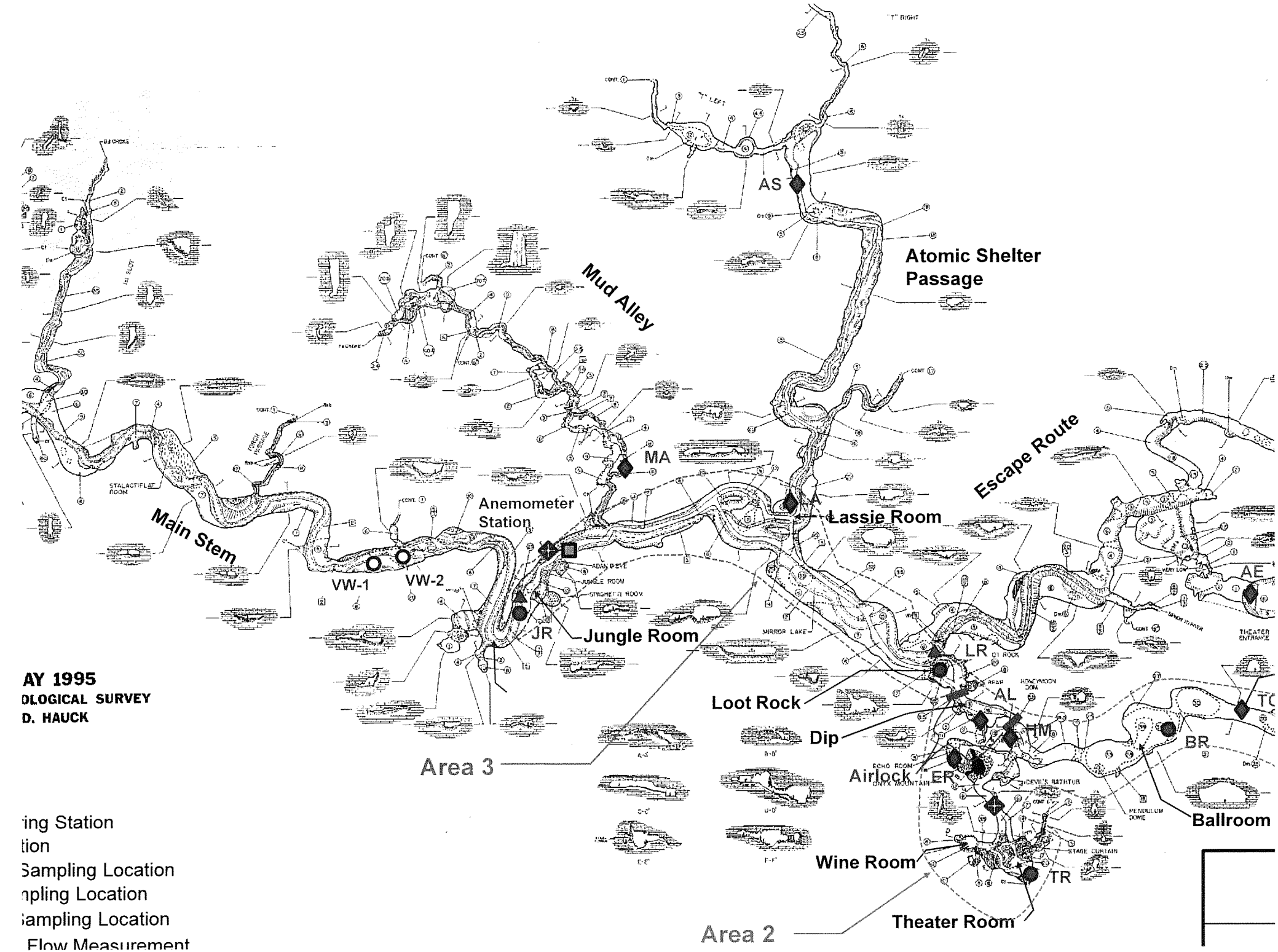
Table 1
Summary of Cave Air and Water Sampling Locations
TRW Automotive
Meramec Caverns
Stanton, MO

ARCADIS

Stationary Sample	Cave Area	Description of Sample Location
Primary Locations		
Gift Shop	1	Behind cash register counter, placed on a rolling cart.
Ballroom	2	On the main stage, placed near the rear of the stage.
Theater	2	Behind the electronic equipment station in a very small side room next to the bleacher seating.
Loot Rock	3	On the stream bank between the handrail and the stream channel as close to the falls as possible.
Jungle Room	3	Approximately 8 feet past the end of trail hand rail between the cave wall and stream bank.
Potential Supplemental Locations		
Cafeteria	1	In the back portion of the cafeteria, placed behind the partitioned section of the seating area.
Ticket Counter	2	Behind the ticket counter
Honeymoon Room	2	In Honeymoon Room.
Echo Room	2	Just past the handrail, placed near the light switching station.
Airlock	2-3	At the mid-point between the air lock doors between the hand rail and the cave wall.
Lassie Room	3	Beyond the handrail and around the first bend that leads up to Atomic Shelter Passage, placed on steps cut into the clay bank that leads to electrical panel.
Atomic Shelter Passa	3	Near the top of the passage at a narrow choke point before the passage splits. The location is marked with survey ribbon tied around a rock .
Mud Alley	3	Approximately 150 feet up passage on a large block of clay located in the center of the passage. The stream channel flows under the large block of clay.
Amphitheater	NA	In the rear of the room, adjacent to largest opening (on right-hand-side) at the top of the sloped back wall.
Outside air blank	NA	Near the gazebo, placed on the river side of the stone wall.

FIGURES


Atomic Shelter Passage
Mud Alley
Escape Route
Main Stem
Lassie Room
Jungle Room
Loot Rock
Dip
Airlock
Ballroom
Wine Room
Theater Room
Area 3
Area 2
AY 1995
DLOGICAL SURVEY
D. HAUCK


AS
Atomic Shelter Passage
Mud Alley
MA
Escape Route
Lassie Room
Anemometer Station
Main Stem
VW-1
VW-2
JR
Jungle Room
LR
Loot Rock
AL
Dip
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Airlock
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Flow Measurement

APPENDIX A

Indoor Air or Ambient Air Sampling and Analysis
Using USEPA Method TO-15
SOP # 765199

APPENDIX A

INDOOR AIR OR AMBIENT AIR SAMPLING AND ANALYSIS USING USEPA METHOD TO-15

SOP # 765199

Rev. #: 2

Rev. Date: July 7, 2010

Project-Specific Modifications: June 23, 2016

Approval Signatures

Prepared by: Date: _____ Date: April 26, 2016
Michael Cobb

Approved: _____ by: Date: April 26, 2016
Mitch Wacksman

I. Scope and Application

This standard operating procedure (SOP) describes the procedures to collect indoor air or ambient air samples for the analysis of volatile organic compounds (VOCs) using United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). The TO-15 method uses a 6-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA® canister (<28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5 liters when allowed to fill to a vacuum of 5 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and provide detailed instructions for placing the sampling device and collecting indoor air samples for VOC analysis.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading indoor air sample collection activities must have previous indoor air sampling experience.

III. Health and Safety Considerations

All sampling personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task.

IV. Equipment List

The equipment required for indoor air sample collection is presented below:

- 6-liter, stainless steel SUMMA® canisters (order at least one extra, if feasible);
- Flow controllers with in-line particulate filters and vacuum gauges (flow controllers are pre-calibrated by the laboratory to a specified sample duration [e.g., 8-hour]). Confirm with lab that flow controller is equipped with an in-line particulate filter and pressure gauge (order an extra set for each extra SUMMA® canister, if feasible);
- Appropriate-sized open-end wrenches (typically 9/16-inch);
- Chain-of-custody (COC) form;

- Sample collection log (attached);
- Camera if photography is permitted at sampling locations;
- Box, chair, tripod, or similar to hold canister above the ground surface; and
- Teflon sample tubing may be used to sample abnormal situations (i.e., sumps, where canisters must be hidden, etc.). In these situations ¼-inch Swagelok fittings or other methods may be appropriate to affix tubing to canister. Staff should check this before heading out into field.

V. Cautions

Care must be taken to minimize the potential for introducing interferences during the sampling event. As such, keep ambient air canisters away from heavy pedestrian traffic areas (e.g., main entranceways, walkways) if possible. Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes before and/or during the sampling event.

Ensure that the flow controller is pre-calibrated to the proper sample collection duration (confirm with laboratory). Sample integrity can be compromised if sample collection is extended to the point that the canister reaches atmospheric pressure. Sample integrity is maintained if sample collection is terminated prior to the target duration and a measurable vacuum (e.g., -5–inches Hg) remains in the canister when sample collection is terminated.

VI. Procedure

Preparation of SUMMA®-Type Canister and Collection of Sample

1. Record the following information on the sampling form (use a hand-held weather meter, contact the local airport or other suitable information source [e.g., weatherunderground.com] to obtain the following information):

- ambient temperature;
- barometric pressure;
- wind speed; and
- relative humidity.

2. Choose the sample location in accordance with the sampling plan. If a breathing zone sample is required, place the canister on a ladder, tripod, box, or other similar stand to locate the canister orifice 3 to 5 feet above ground or floor surface. Canister may be affixed to wall/ceiling support with nylon rope or placed on a stable surface. In general, areas near windows, doors, air supply vents, and/or other potential sources of "drafts" shall be avoided.
3. Record SUMMA® canister serial number and flow controller number on the sampling log and chain of custody (COC) form. Assign sample identification on canister ID tag, and record on the sample collection log (Attachment B), and COC form.
4. Remove the brass dust cap from the SUMMA® canister. Attach the flow controller and vacuum gauge to the SUMMA® canister with the appropriate-sized wrench. Tighten with fingers first, then gently with the wrench. Use caution not to over tighten fittings.
5. Open the SUMMA® canister valve to initiate sample collection. Record the date and local time (24-hour basis) of valve opening on the sample collection log, and COC form. Collection of duplicate samples will include collecting two samples side by side at the same time. The use of T-fittings and Teflon® lined tubing may be used to connect the duplicate and parent sample ports such that both sample canisters are collecting ambient air from the same sample port.
6. Record the initial vacuum pressure in the SUMMA® canister on the sample log and COC form. If the initial vacuum pressure registers less than -25 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.
7. If feasible, check the SUMMA canister approximately half way through the sample duration and note progress on sample logs.

Termination of Sample Collection

1. Arrive at the SUMMA® canister location at least 1-2 hours prior to the end of the sampling interval (e.g., 8-hour).
2. Stop collecting the sample when the canister vacuum reaches approximately 5 inches of Hg (leaving some vacuum in the canister provides a way to verify if the canister leaks before it reaches the laboratory) or when the desired sample time has elapsed, whichever comes first.
3. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valve. Record the date, local time (24-hour basis) of valve closing on the sample collection log, and COC form.

4. Remove the flow controller from the SUMMA® canister, re-install brass cap on canister fitting, and tighten with wrench.
5. Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.
6. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with string).
7. Complete COC form and place requisite copies in shipping container. Close shipping container and affix custody seal to container closure. Transmit canisters to laboratory (e.g., Federal Express, UPS, courier) for analysis.

VII. Waste Management

No specific waste management procedures are required.

VIII. Data Recording and Management

Notes taken during the initial building survey will be recorded on the sample log, with notations of project name, sample date, sample time, and sample location (e.g., description and GPS coordinates if available) sample start and finish times, canister serial number, flow controller number, initial vacuum reading, and final vacuum reading. Sample logs and COC records will be transmitted to the Task Manager or Project Manager

IX. Quality Assurance

Collect quality assurance samples as required by project-specific work plan or Quality Assurance Project Plan (QAPP).

ARCADIS Design & Consultancy for natural and built assets

Indoor Air/Ambient Air Sample Collection Log

		Sample ID:	
Client:		Outdoor/Indoor:	
Project:		Sample Intake Height:	
Location:		Tubing Information:	
Project #:		Miscellaneous Equipment:	
Samplers:		Time On/Off:	
Sample Point Location:		Subcontractor:	

Instrument Readings:

Date	Time	Canister Vacuum (a) (inches of Hg)	Temperature (°F)	Relative Humidity (%)	Air Speed (mph)	Barometric Pressure (inches of Hg)	PID (ppb)

(a) Record canister information at a minimum at the beginning and end of sampling

SUMMA Canister Information:

Size (circle one):	1 L	6 L
Canister ID:		
Flow Controller ID:		
Notes:		

General Observations/Notes:

APPENDIX B

Cut Sheets

ENERGY AND COMFORT

Ventilation Testing

VELOCICALC®
Air Velocity Meter
Model 9555 Series

Operation and Service Manual

TSI TRUST SCIENCE INNOVATION

Address
TSI Incorporated / 500 Cardigan Road / Shoreview, MN 55126 / USA

Fax No.
(651) 490-3824

LIMITATION OF WARRANTY AND LIABILITY (effective July 2000)

Seller warrants the goods sold hereunder, under normal use and service as described in the operator's manual, shall be free from defects in workmanship and material for twenty-four (24) months, or the length of time specified in the operator's manual, from the date of shipment to the customer. This warranty period is inclusive of any statutory warranty. This limited warranty is subject to the following exclusions:

a. Hot-wire or hot-film sensors used with research anemometers, and certain other components when indicated in specifications, are warranted for 90 days from the date of shipment.
b. Parts repaired or replaced as a result of repair services are warranted to be free from defects in workmanship and material, under normal use, for 90 days from the date of shipment.
c. Seller does not provide any warranty on finished goods manufactured by others or on any fuses, batteries or other consumable materials. Only the original manufacturer's warranty applies.
d. Unless specifically authorized in a separate writing by Seller, Seller makes no warranty with respect to, and shall have no liability in connection with, goods which are incorporated into other products or equipment, or which are modified by any person other than Seller.

The foregoing is IN LIEU OF all other warranties and is subject to the LIMITATIONS stated herein. **NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE.**

TO THE EXTENT PERMITTED BY LAW, THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF SELLER'S LIABILITY FOR ANY AND ALL LOSSES, INJURIES, OR DAMAGES CONCERNING THE GOODS (INCLUDING CLAIMS BASED ON CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) SHALL BE THE RETURN OF GOODS TO SELLER AND THE REFUND OF THE PURCHASE PRICE, OR, AT THE OPTION OF SELLER, THE REPAIR OR REPLACEMENT OF THE GOODS. IN NO EVENT SHALL SELLER BE LIABLE FOR ANY SPECIAL, CONSEQUENTIAL OR INCIDENTAL DAMAGES. SELLER SHALL NOT BE RESPONSIBLE FOR INSTALLATION, DISMANTLING OR REINSTALLATION COSTS OR CHARGES. No Action, regardless of form, may be brought against Seller more than 12 months after a cause of action has accrued. The goods returned under warranty to Seller's factory shall be at Buyer's risk of loss, and will be returned, if at all, at Seller's risk of loss.

Buyer and all users are deemed to have accepted this LIMITATION OF WARRANTY AND LIABILITY, which contains the complete and exclusive limited warranty of Seller. This LIMITATION OF WARRANTY AND LIABILITY may not be amended, modified or its terms waived, except by writing signed by an Officer of Seller.

Service Policy

Knowing that inoperative or defective instruments are as detrimental to TSI as they are to our customers, our service policy is designed to give prompt attention to any problems. If any malfunction is discovered, please contact your nearest sales office or representative, or call Customer Service department at (800) 874-2811 (USA) or (1) 651-490-2811 (International).

CONTENTS

Chapter 1

Unpacking and Parts Identification

Carefully unpack the instrument and accessories from the shipping container. Check the individual parts against the list of components below. If anything is missing or damaged, notify TSI immediately.

1. Carrying case
2. Instrument
3. Static pressure tip
4. Rubber tubing
5. USB cable
6. CD-ROM with downloading software
7. AC adapter

Chapter 2

Setting-up

Supplying Power to the Model 9555 Series

The Model 9555 VELOCICALC Air Velocity Meter can be powered in one of two ways: four size AA batteries or the AC adapter.

Installing the Batteries

Insert four AA batteries as indicated by the diagram located on the inside of the battery compartment. The Model 9555 is designed to operate with either alkaline or NiMH rechargeable batteries. Battery life will be shorter if NiMH batteries are used. If NiMH batteries are used the DIP switch will need to be changed. Refer to Appendix B, DIP Switch Settings. Carbon-zinc batteries are not recommended because of the danger of battery acid leakage.

Using the AC Adapter

When using the AC adapter, the batteries (if installed) will be bypassed. Be sure to provide the correct voltage and frequency, which is marked on the back of the AC adapter.

Using The Telescoping Probe

The telescoping probe contains the velocity, temperature, and humidity sensors. When using the probe, make sure the sensor window is fully exposed and the orientation dimple is facing upstream.

NOTE: *For temperature and humidity measurements, make sure that at least 3 inches (7.5 cm) of the probe is in the flow to allow the temperature and humidity sensors to be in the air stream.*

Extending The Probe

To extend the probe, hold the handle in one hand while pulling on the probe tip with the other hand. Do not hold the cable while extending the probe as this prevents the probe from extending.

Retracting The Probe

To retract the probe, hold the handle in one hand while gently pushing on the probe tip with the other hand. If you feel the probe antenna binding, pull gently on the probe cable until the smallest antenna section is retracted. Collapse the rest of the antenna by pressing the probe tip.

Connecting the Optional Bluetooth Portable Printer

To connect the Bluetooth printer to the Model 9555, power on the unit and the printer. Then select the MENU soft key. From the Menu use the ▲ and ▼ keys to highlight Discover Printer and press the ↵ key. If other TSI Bluetooth-printers are in the area, turn them off before searching. The Model 9555 will then search for and list all available Bluetooth devices. Select the device "Handy700".

If the Model 9555 has previously been connected to a TSI printer, then it should automatically reconnect to that printer.

If the printer prints question marks (??????), asterisks (******), or random characters, reset it by turning it off and then on again. If necessary, refer to the *Portable Printer Manual.*

Connecting to a Computer

Use the Computer Interface USB Cable provided with the Model 9555 to connect the instrument to a computer for downloading stored data or for remote polling. Connect the end labeled "COMPUTER" to the computer USB port and the other end to the data port of the Model 9555.

For more information on how to download stored data see Chapter 3 section titled TrakPro™ Data Analysis Software.

Caution: This symbol is used to indicate that the data port of the Model 9555 is **not** intended for connection to a public telecommunications network. Connect the USB data port only to another USB port.

Chapter 3

Operation

Keypad Functions

ON/OFF Key	Press to turn the Model 9555 on and off. During the power up sequence the display will show the following: Model Number, Serial Number, Software Revision and Last Date Calibrated.
Arrow (▲▼) Keys	Press to scroll through choices while setting a parameter. Pressing the ▲▼ keys simultaneously will lock the keypad to prevent unauthorized adjustments to the instruments. To unlock the keypad, press the ▲▼ keys simultaneously.
↵ (Enter) Key	Press to accept a value or condition.
Arrow (◀or ▶) and Menu Soft Keys	Press arrow keys to change choices while setting a parameter. Press the Menu soft key to select the Menu selections, which are Display Setup, Pressure Zero, Settings, Flow Setup, Actual/Std Set up, Data Logging, Applications, Calibration and Printer.

Common Terms

In this manual there are several terms that are used in different places. The following is a brief explanation of the meanings of those terms.

Sample	Consists of all of the measurement parameters stored at the same time.
Test ID	A group of samples. The statistics (average, minimum, maximum, and count) are calculated for each test ID. The maximum number of test IDs is 100.

Time Constant	The time constant is an averaging period. It is used to dampen the display. If you are experiencing fluctuating flows, a longer time constant will slow down those fluctuations. The display will update every second, but the displayed reading will be the average over the last time constant period. For example, if the time constant is 10 seconds, the display will update every second, but the displayed reading will be the average from the last 10 seconds. This is also referred to as a "moving average".
Logging Interval	The logging interval is a frequency period that the instrument will log readings. For example, if the logging interval is set to 30 minutes, each sample will be the average of the last 30 minutes.

Menus

DISPLAY SETUP

Display setup menu is where you will setup the desired parameters to be displayed on the running screen. With a parameter highlighted you can then use the ON soft key to have it show up on the running screen or select the OFF soft key to turn off the parameter. Use PRIMARY soft key to have a parameter show up on the running screen in a larger display. Only one parameter can be selected as a primary, and up to 4 secondary parameters can be selected at one time.

PRESSURE ZERO

To zero the pressure reading, select the Pressure Zero menu. The instrument will indicate if the pressure zero was successful.

SETTINGS

Settings menu is where you can set the general settings. These include Language, Beeper, Select Units, Time Constant, Contrast, Set Time, Set Date, Time Format, Date Format, Number Format, Backlight and Auto Off. Use the ◄ or ► soft keys to adjust the settings for each option and use the ↵ key to accept settings.

FLOW SET UP

In Flow Setup mode, there are 5 types: Round Duct, Rectangle Duct, Duct Area, Horn and K-Factor. Use the ◄ or ► soft keys to scroll through the types and then press the ↵ key to accept the desired type. To change the value, highlight the Enter Settings option and press the ↵ key.

NOTE: The horn numbers are the models of the horns. For example, 100 refers to a horn model number AM 100. Only horns with Model numbers as follows can be used with this function: AM 100, AM 300, AM 600 and AM 1200. If a horn model number is chosen, the instrument will return to measuring mode and use a preprogrammed curve to calculate flow rate from velocity.

ACTUAL/STANDARD SETUP

Choose Actual/Standard measurements and parameters in the Act/Std Setup menu. Within this menu, the user can also select Standard Temperature, Standard Pressure and a source for the actual temperature. The Model 9555 measures the actual barometric pressure.

DATA LOGGING

Measurements

Measurements to be logged are independent of measurements on the display, and must therefore be selected under DATA LOGGING → Measurements.

Log Mode/Log Settings

You can set Log Mode to Manual, Auto-save, Cont-key, Cont-time, Program 1 or Program 2.

- Manual mode does not automatically save data, but instead prompts the user to save a sample.
- In Auto-save mode, the user manually takes samples that are automatically logged.
- In Cont-key mode, the user starts taking readings and logging by pressing the ↵ key. The instrument will continue taking measurements until the ↵ key is pressed again.
- In Cont-time mode, the user starts taking readings by pressing the ↵ key. The instrument will continue taking samples until a set period of time has passed.
- Auto-save, Cont-Key and Cont-time modes have the following additional Log Settings:

Mode	Log Settings
Auto-save	Log Interval
Cont-key	Log Interval
Cont-time	Log Interval
	Test Length

- Pressing the ▲▼ keys simultaneously will lock the keypad to prevent unauthorized adjustments to the instruments. To unlock the keypad, press the ▲▼ keys simultaneously.

Delete Data

Use this to delete all data, delete test or delete sample.

% Memory

This option displays the memory available. Delete All, under Delete Data, will clear memory and reset the memory available.

APPLICATIONS

You can choose Draft Rate, Heat flow, Turbulence and % Outside Air in the Applications menu. After choosing one of these applications, take measurements or enter data for each line.

Printing Data Using the Portable Printer

To print logged data, first enter the DATALOGGING menu. Then, use the CHOOSE TEST item to select the data to be printed. After the test is selected, use the VIEW STATS and VIEW SAMPLES items to select statistics or individual data points to view and print. After selecting VIEW STATS or VIEW SAMPLES, press the PRINT key to print the data.

TRAKPRO™ Data Analysis Software

The VELOCICALC Model 9555 comes with special software called TRAKPRO™ Data Analysis Software, which is designed to provide you with maximum flexibility and power. To install this software on your computer, follow the instructions on the label of the TRAKPRO software.

Follow the instructions on the label of the TRAKPRO software to install the software on your computer. TRAKPRO software contains a very comprehensive Help Function. This utility provides all the necessary information to guide you in all aspects of software operation. The software is shipped on a CD-ROM. Updates are available from the TSI website at http://software.tsi.com.

To download data from the Model 9555, connect the supplied computer interface USB cable to the Model 9555 and to a computer USB port. Any USB port from can be used.

Chapter 4

Maintenance

The Model 9555 requires very little maintenance to keep it performing well.

Recalibration

To maintain a high degree of accuracy in your measurements, we recommend that you return your Model 9555 to TSI for annual recalibration. Please contact one of TSI's offices or your local distributor to make service arrangements and to receive a Return Material Authorization (RMA) number. To fill out an online RMA form, visit TSI's website at http://service.tsi.com.

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Fax: (651) 490-3824

The Model 9555 can also be recalibrated in the field using the CALIBRATION menu. These field adjustments are intended to make minor changes in calibration to match a user's calibration standards. The field adjustment is NOT intended as a complete calibration capability. For complete, multiple-point calibration and certification, the instrument must be returned to the factory.

Cases

If the instrument case or storage case needs cleaning, wipe it off with a soft cloth and isopropyl alcohol or a mild detergent. Never immerse the Model 9555. If the enclosure of the Model 9555 or the AC adapter becomes broken, it must be replaced immediately to prevent access to hazardous voltage.

Storage

Remove the batteries when storing the unit for more than one month to prevent damage due to battery leakage.

Chapter 5

Troubleshooting

Table 5-1 lists the symptoms, possible causes, and recommended solutions for common problems encountered with the Model 9555. If your symptom is not listed, or if none of the solutions solves your problem, please contact TSI.

Table 5-1: Troubleshooting the Model 9555

Symptom	Possible Causes	Corrective Action
No Display	Unit not turned on	Switch unit on.
	Low or dead batteries	Replace batteries or plug in AC adapter.
	Dirty battery contacts	Clean the battery contacts.
Velocity reading fluctuates unstable	Fluctuating flow	Reposition probe in less-turbulent flow or use longer time constant.
No response to keypad	Keypad locked out	Unlock keypad by pressing ▲▼ keys simultaneously.
Instrument Error message appears	Memory is full	Download data if desired, then DELETE ALL memory.
	Fault in instrument	Factory service required on instrument.
Probe Error message appears	Fault in probe	Factory service required on probe.

WARNING!

Remove the probe from excessive temperature immediately: excessive heat can damage the sensor. Operating temperature limits can be found in Appendix A, Specifications. The pressure sensor is protected from damage up to 7 psi (48 kPa or 360 mmHg). At higher pressure it can burst!

Appendix A

Specifications

Specifications are subject to change without notice.

Velocity (TA Probe):

Range:	0 to 9999 ft/min (0 to 50 m/s)
Accuracy[1&2]:	±3% of reading or ±3 ft/min (±0.015 m/s), whichever is greater
Resolution:	1 ft/min (0.01 m/s)

Velocity (Pitot Tube):

Range[3]:	250 to 15500 ft/min (1.27 to 78.7 m/s)
Accuracy[4]:	±1.5% at 2000 ft/min (10.16 m/s)
Resolution:	1 ft/min (0.01 m/s)

Duct Size:

Range:	1 to 500 inches in increments of 0.1 in. (2.5 to 1270 cm in increments of 0.1 cm)

Volumetric Flow Rate:

Range:	Actual range is a function of actual velocity, pressure, duct size, and K factor

Temperature (TA Probe):

Range:	14 to 140°F (-10 to 60°C)
Accuracy[5]:	±0.5°F (±0.3°C)
Resolution:	0.1°F (0.1°C)

Relative Humidity(TA Probe):

Range:	0 to 95% RH
Accuracy[6]:	±3% RH
Resolution:	0.1% RH

Wet Bulb Temperature (TA Probe):

Range:	40 to 140°F (5 to 60°C)
Resolution:	0.1°F (0.1°C)

Dew Point (TA Probe):

Range:	5 to 120°F (-15 to 49°C)
Resolution:	0.1°F (0.1°C)

Heat Flow (TA Probe):

Range:	Function of velocity, temperature, humidity, and barometric pressure
Measurements available:	Sensible heat flow, latent heat flow, total heat flow and sensible heat factor
Units measured:	BTU/hr, kW

Static / Differential Pressure:
Range[7]: -15 to +15 in. H_2O (-28.0 to +28.0 mm Hg, -3735 to +3735 Pa)
Accuracy: ±1% of reading ±0.005 in. H_2O (±1 Pa, ±0.01 mm Hg)
Resolution: 0.001 in. H_2O (0.1 Pa, 0.01 mm Hg)

Barometric Pressure:
Range: 20.36 to 36.648 in. Hg (517.15 to 930.87 mm Hg)
Accuracy: ±2% of reading

Instrument Temperature Range:
Operating (Electronics): 40 to 113°F (5 to 45°C)
Operating (Probe): 14 to 140°F (-10 to 60°C)
Storage: -4 to 140°F (-20 to 60°C)

Instrument Operating Conditions:
Altitude up to 4000 meters
Relative humidity up to 80% RH, non-condensing
Pollution degree 1 in accordance with IEC 664
Transient over voltage category II

Data Storage Capabilities:
Range: 26,500+ samples and 100 test IDs (one sample can contain fourteen measurement types)

Logging Interval:
Intervals: 1 second to 1 hour

Time Constant:
Intervals: User selectable

Response Time:
Velocity: 200 msec
Temperature: 2 minutes (to 66% of final value)
Pressure: 0.1 msec
Humidity: <1 minute (to 66% of final value)

External Meter Dimensions:
3.8 in. × 8.3 in. × 2.1 in. (9.7 cm × 21.1 cm × 5.3 cm)

Meter Probe Dimensions:
Probe length: 40 in. (101.6 cm)
Probe diameter of tip: 0.28 in. (7.0 mm)
Probe diameter of base: 0.51 in. (13.0 mm)

Articulating Probe Dimensions:
Articulating section length: 6.0 in. (15.24 cm)
Diameter of articulating knuckle: 0.38 in. (9.5 mm)

Meter Weight:
Weight with batteries: 0.8 lbs (0.36 kg)

Power Requirements:
Four AA-size batteries (included) or AC adapter (optional) 7.2 VDC, 300 mA, 4-18 watts (input voltage and frequency vary depending on which adapter is used)

1 Temperature compensated over an air temperature range of 40 to 150°F (5 to 65°C).

2 The accuracy statement of ±3.0% of reading or ±3 ft/min (±0.015 m/s), whichever is greater, begins at 30 ft/min through 9999 ft/min (0.15 m/s through 50 m/s).

3 Pressure velocity measurements are not recommended below 1000 ft/min (5 m/s) and are best suited to velocities over 2000 ft/min. Range can vary depending on barometric pressure.

4 Accuracy is a function of converting pressure to velocity. Conversion accuracy improves when actual pressure values increase.

5 Accuracy with instrument case at 77°F (25°C), add uncertainty of 0.05°F/°F (0.03°C/°C) for change in instrument temperature.

6 Accuracy with probe at 77°F (25°C). Add uncertainty of 0.1% RH/°F (0.2% RH/°C) for change in probe temperature. Includes 1% hysteresis.

7 Overpressure range = 190 in. H_2O (7 psi , 360 mmHg, 48 kPa).

Appendix B

DIP Switch Settings

To access the DIP switch, remove the batteries from the battery compartment. On the inside of the battery compartment, there is a window with a single DIP switch (see Figure B-1). The table below shows the functions for the switch.

Caution: Make certain that power is turned off before changing the DIP switch settings.

Switch	Function	Settings
1	NiMH	OFF: Alkaline Batteries ON: NiMH Rechargeable Batteries

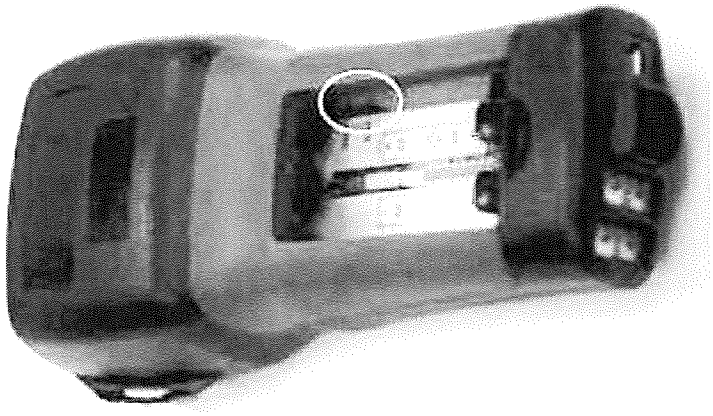


Figure B-1: DIP Switch Location

TSI Incorporated – 500 Cardigan Road, Shoreview, MN 55126 U.S.A

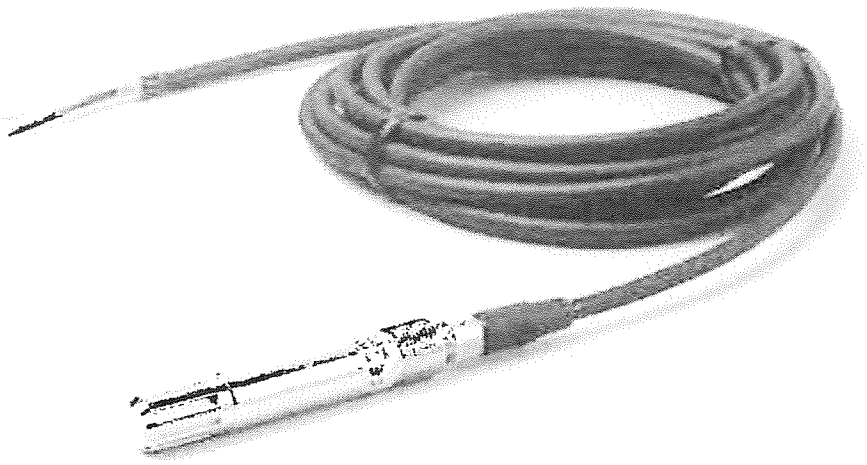
USA	**Tel:** +1 800 874 2811	**E-mail:** info@tsi.com	**Website:** www.tsi.com
UK	**Tel:** +44 149 4 459200	**E-mail:** tsiuk@tsi.com	**Website:** www.tsiinc.co.uk
France	**Tel:** +33 491 95 21 90	**E-mail:** tsifrance@tsi.com	**Website:** www.tsiinc.fr
Germany	**Tel:** +49 241 523030	**E-mail:** tsigmbh@tsi.com	**Website**: www.tsiInc.de
India	**Tel:** +91 80 41132470	**E-mail:** tsi-india@tsi.com	
China	**Tel:** +86 10 8260 1595	**E-mail:** tsibeijing@tsi.com	

Contact your local TSI Distributor or visit our website **www.tsi.com** for more detailed specifications.

P/N 1980565 Rev F Printed in U.S.A.

VAISALA www.vaisala.com

Vaisala INTERCAP® Humidity and Temperature Probe HMP60



The HMP60 for extreme conditions.

Features/Benefits

- Miniature-size humidity probe
- Low power consumption
- Measurement range 0 100 %RH; -40 .. +60°C
- Cable detachable with standard M8 connector
- Rugged metal housing
- Interchangeable Vaisala INTERCAP® Sensor
- Optional RS485 digital output
- Optional dew point output
- Applications volume applications, integration into other manufacturers' equipment, glove boxes, greenhouses, fermentation chambers, data loggers

HMP60

The HMP60 is a simple, durable and cost-effective humidity probe. It is suitable for volume applications, integration into other manufacturers' equipment, incubators, glove boxes, greenhouses, fermentation chambers, and data loggers.

Easy Installation

The probe cable has a screw-on quick connector for easy installation. Different cable lengths are available. Also other compatible M8 series cables can be used. Accessories are available for different installation needs.

Low Current Consumption

The HMP60 is suitable for battery-powered applications because of its very low current consumption.

Several Outputs

There are two configurable voltage outputs with relative humidity, temperature or dew point scaling. Four voltage output ranges are available.

Rugged Design

The HMP60 is designed for extreme conditions. The stainless steel body of the HMP60 is classified as IP65. The probe has a sealed structure and the sensor is protected by a membrane filter and a plastic grid, or optionally by a stainless steel filter.

Recalibration Not Needed

The Vaisala INTERCAP® Sensor is interchangeable. No recalibration is required; the sensor can simply be replaced, also in the field.

Technical Data

Performance

RELATIVE HUMIDITY	
Measurement range	0 ... 100 %RH
Typical accuracy	
temperature range	0 ... +40 °C
0 ... 90 %RH	±3 %RH
90 ... 100 %RH	±5 %RH
temperature range	-40 ... 0 °C, +40 ... +60 °C
0 ... 90 %RH	±5 %RH
90 ... 100 %RH	±7 %RH
Humidity sensor	Vaisala INTERCAP®
TEMPERATURE	
Measurement range	-40 ... +60 °C
Accuracy over temperature range	
+10 ... +30 °C	±0.5 °C
-40 ... +10, +30 ... +60 °C	±0.6 °C
DEW POINT	
Measurement range	-40 ... +60 °C
Typical accuracy	
temperature range	0 ... +40 °C
when dew point depression < 15 °C	±2 °C
temperature range	-40 ... 0 °C, +40 ... +60 °C
when dew point depression < 10 °C	±3 °C
dew point depression = ambient temperature - dew point	
ANALOG OUTPUTS	
Accuracy at 20 °C	±0.2 % of FS
Temperature dependence	±0.01 % of FS/°C

Inputs and Outputs

Operating voltage	5 ... 28 VDC / 8 ... 28 VDC with
(Use lowest available operating	5 V output
voltage to minimize heating.)	8 ... 28VDC with loop power converter
Current consumption	1 mA average, max. peak 5 mA
Start-up time	
probes with analog output	4 s at operating voltage 13.5 ... 16.5 VDC
	2 s at other valid operating voltages
probes with digital output	1 s
Outputs	
2 channels	0 ... 1 VDC/0 ... 2.5 VDC / 0 ... 5 VDC/1 ... 5 VDC
1-channel loop-power converter (separate module, compatible with humidity accuracy only)	4 ... 20 mA
digital output (optional)	RS485 2-wire half duplex
External loads	
0 ... 1 V	R_L min 10 kΩ
0 ... 2.5 V /0 ... 5 V	R_L min 50 kΩ

Operating Environment

Operating temperature	-40 ... +60 °C
Electromagnetic compatibility	EN 61326-1: Electrical equipment for measurement, control and laboratory use – EMC requirements – for use in industrial locations.

Mechanics

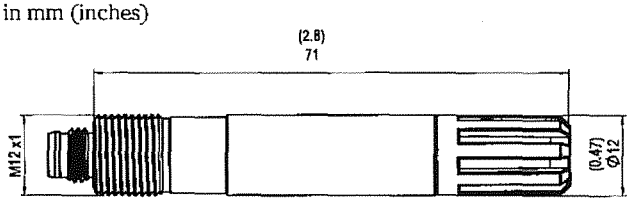
Materials	
body	stainless steel (AISI 316)
grid filter	chrome coated ABS plastic
cable	polyurethane or FEP
Housing classification	IP65
Body thread	MI2x1 / 10 mm
Cable connector	4-pin M8 (IEC 60947-5-2)
Weight	
probe	17 g
probe with 0.3 m cable	28 g

Options and Accessories

Vaisala INTERCAP® Sensor, 1 piece	15778HM
Vaisala INTERCAP® Sensor, 10 pcs	INTERCAPSET-10PCS
Sensor protection	
plastic grid	DRW010522
membrane filter	DRW010525
stainless steel sintered filter	HM46670SP
4 ... 20mA loop power converter	UI-CONVERTER-1CB
Mounting bracket for converter	225979
Plastic M12 installation nuts, pair	18350SP
USB cable for PC connection	219690
Probe mounting clamp set, 10 pcs	226067
Probe mounting flange	226061
Connection cables	
0.3 m PU	HMP50Z032SP
3 m PU	HMP50Z300SP
180 °C 3 m FEP	226902SP

Dimensions

in mm (inches)



VAISALA

Please contact us at
www.vaisala.com/requestinfo

www.vaisala.com

...the code for
...information

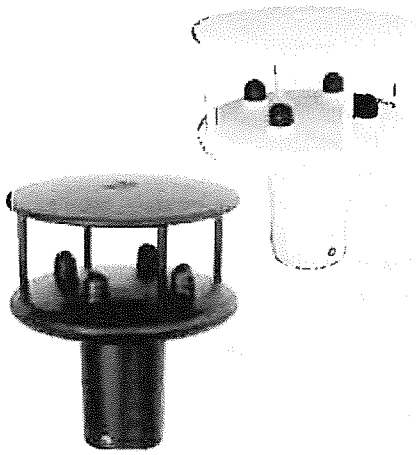
WindSonic™ SDI-12

Wind Speed & Direction Sensor

GILL

Key Features

- **Low Power Operation <2mA**
- **Rolling Average Facility**
- **SDI-12 V1.3 Compatible**
- **Multiple Sensors (Maximum 10)**
- **Solid State – Maintenance Free**
- **2 Year Warranty**
- **Corrosion Free**



The WindSonic™ SDI-12 is a low cost anemometer, utilising Gill's proven ultrasonic technology to provide wind speed and direction data via an SDI-12 output. New features include lower power consumption <2mA in standby and a vector or scalar rolling average feature providing 1 min average and 1 min max speed with associated direction.

With a robust, corrosion-free polycarbonate housing, this small, lightweight wind sensor is particularly suited to meteorological and hydrological based installations. The WindSonic™ has no moving parts, offering maintenance-free operation in a wide range of applications.

WIND SPEED

Range	0 - 60 m/s (116 knots)
Accuracy	±2% @12 m/s
Resolution	0.01 m/s (0.02 knots)
Response Time	0.25 seconds
Threshold	0.01 m/s

DIRECTION

Range	0 - 359° (No dead band)
Accuracy	±2° @12 m/s
Resolution	1°
Response Time	0.25 seconds

MEASUREMENT

Update rate (for polling)	1 Hz
Parameters	Wind Speed & Direction or U and V (vectors)
Units of Measure	m/s

OUTPUTS

Output type	SDI-12 (refer to manual for technical specification) SDI-12 v 1.3
Baud Rate	1200
Anemometer Status	Supplied as part of standard message

AVERAGING

Rolling Average (normal power operation only)	1 Min Vector or 1 Min Scalar
	1 Min Maximum Speed & Direction

POWER REQUIREMENT

Anemometer (polled at 1Hz)	<2 mA @12 V - Low power operation
	<10 mA @12 V - Normal power operation

MECHANICAL

External Construction	LURAN S KR 2861/1C ASA/PC
Size	142mm x 163mm
Weight	0.5kg

ENVIRONMENTAL

Protection Class	IP66
Operating Temperature	-35°C to +70°C
Storage Temperature	-40°C to +80°C
Operating Humidity	< 5% to 100% RH
EMC	EN 61326: 1998

OPERATIONAL

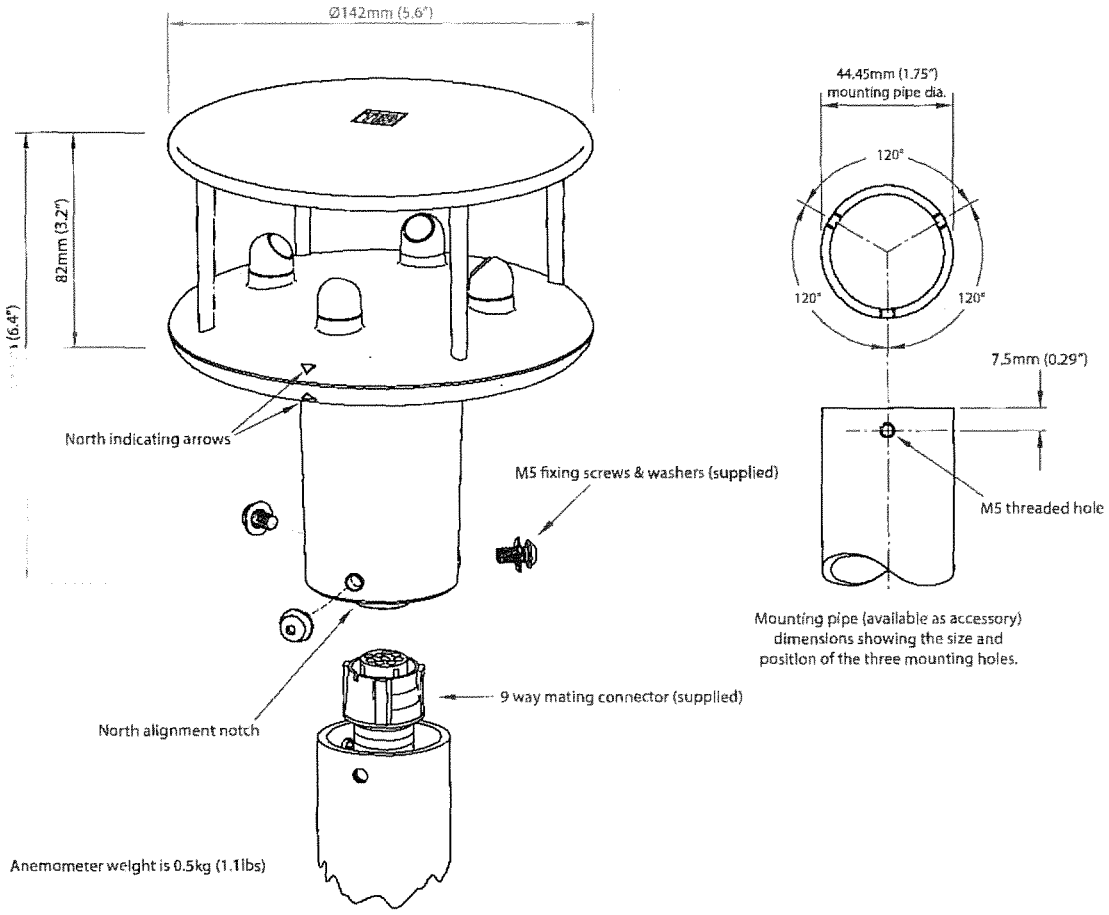
MTBF	15 years
Warranty	2 years
Factory Calibration	Traceable to National Standards

ACCESSORIES

Pipe Mounting	44.45mm (1.75") dia x 500mm length
Cables	Available to match output options

Typical Applications

- Remote weather monitoring stations
- Environmental field sites
- Agricultural Met
- Pollution Control
- Utilities
- Hydrological
- HVAC
- Environmental Protection



This product is in continuous development and therefore specifications may be subject to change without prior notice.

Gill Instruments

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United Kingdom

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Fax: +44 (0) 1590 613 501
info@gillinstruments.com

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1405-0028 Iss 2

Gill Instruments Ltd, Reg No. 2281574
Registered Office: The College Business Centre, Christchurch Road, Milton, BH25 6QJ

ARCADIS Design & Consultancy for natural and built assets

Arcadis U.S., Inc.

Rosehill Office Park 1

8725 Rosehill

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Lenexa, Kansas 66215

Tel 913 492 0900

Fax 913 492 0902

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APPENDIX D
ADMINISTRATIVE SETTLEMENT AGREEMENT
CERCLA DOCKET No. CERCLA-07-2016-0012

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 7
11201 Renner Boulevard
Lenexa, Kansas 66219

ENFORCEMENT ACTION MEMORANDUM

SUBJECT: Request for Time-Critical Removal Action at the Oak Grove Village Well Site, Oak Grove Village, Franklin County, Missouri

FROM: for Tonya Howell, Remedial Project Manager
Missouri/Kansas Remedial Branch

THRU: Lynn Juett, Chief
Missouri/Kansas Remedial Branch

TO: Mary P. Peterson, Director
Superfund Division

Site ID#:	07PZ
Sequence No:	BB001
CERCLIS ID#:	MOD981717036
Nationally Significant:	No
Category of Removal:	Time-Critical

I. PURPOSE

The purpose of this Action Memorandum is to request and document approval of the proposed PRP-lead, time-critical removal action for the Oak Grove Village Well Site, located in Franklin County, Missouri. The purpose of this action is to implement engineering systems to reduce TCE exposures. This action will insure that employees at the La Jolla Spring Cave Complex are not exposed to unacceptable levels of TCE in air while in the gift shop and the cavern by implementing mitigation systems including ventilation wells, air locks, air filters, improved ventilation, and use of an alternative water supply for washing activities in Meramec Caverns.

This removal action will be conducted by the following Potentially Responsible Parties (PRPs): TRW Automotive U.S.A, LLC; Meramec Industries; and the City of Sullivan, Missouri. The U.S. Environmental Protection Agency will perform oversight of the PRPs' work, including review and approval of all work plans and reports, and oversight of field activities. This is the second time-critical removal action conducted at this Site. The first removal was an EPA fund-lead action initiated on April 9, 2001. The first removal consisted of installing whole-house filtration systems on two homes with TCE-impacted wells.

II. SITE CONDITIONS AND BACKGROUND

Site Name:	Oak Grove Village Well
Superfund Site ID:	07PZ
NRC Case Number:	N/A
CERCLIS Number:	MOD981717036
Site Location:	Franklin County, Missouri
Removal Category:	Time-Critical
Nationally Significant:	No
Potentially Responsible Parties (PRPs):	TRW Automotive U.S.A. LLC; Meramec Industries; and the City of Sullivan, Missouri
NPL Status:	Listed on September 2, 2002

A. Site Description

1. Removal site evaluation

The Oak Grove Village Well Superfund Site (Site) is located in Franklin County, Missouri. The Site was proposed for the National Priorities List (NPL) on September 13, 2001, and the listing became final pursuant to CERCLA Section 105, 42 U.S.C. § 9605, on September 2, 2002.

Oak Grove Village (OGV) is a small rural community with a population of 382. The OGV municipal well #1 (OGV01) was drilled in 1964 and was the only source of drinking water for the village residents for a number of years. The Missouri Department of Natural Resources (MDNR) Public Drinking Water Program detected trichloroethylene (TCE) contamination in OGV01 on June 10, 1986, at 6 parts per billion (ppb) during routine water sampling.

In December 2002, a new municipal well #2 (OGV02) was drilled; however, TCE contamination prevented its use until an air stripper was installed and operational. OGV02, with its air stripper in place, began operation and replaced OGV01 as the source of drinking water for OGV in April 2005.

The location and amount of contamination at the OGV Site varies due to contaminant plume movement, which is influenced by well pumping and karst geology. Since the contamination is widespread, it has impacted private (residential and commercial/industrial) and municipal wells in OGV, Sullivan, and the unincorporated areas in the vicinity of these municipalities, as well as a spring that surfaces inside a cave complex in Stanton, Missouri. The OGV Site includes contamination in groundwater, surface water and cave air.

The Site has been subdivided into two Operable Units. Operable Unit 1 (OU1) includes the contamination in the area of the OGV well, as well as impacted wells in Sullivan. Operable Unit 2 (OU2) includes the closed Sullivan Landfill, as well as nearby wells and springs impacted by contamination from the landfill. Both operable units also include the La Jolla Spring Cave Complex which provides groundwater drainage for the OGV/Sullivan area.

The only sources found to be impacting the Ozark Aquifer are the former TRW/Ramsey Facility and the closed Sullivan Landfill. Contamination in OU1 is originating from the former TRW/Ramsey facility. The PRP is currently working with the MDNR Resource Conservation Recovery Act (RCRA)

Corrective Action program to address the TCE contamination originating from the facility and the closed Sullivan Landfill, which is being addressed by the EPA Superfund program under OU2.

Site History

Since initial detection, the TCE concentrations detected in OGV01 have ranged from 1.5 (November 15, 2000) to 99.6 micrograms per liter (µg/L) (April 29, 2004). Investigations were conducted to determine the location and extent of the contaminant plumes in groundwater impacting area wells. The sample results from area wells determined that TCE and other chemicals of potential concern, such as tetrachloroethylene (PCE) and the degradation products of TCE, had contaminated private (residential and commercial/industrial) and municipal wells, as well as a spring in the OGV area.

The MDNR Remedial Investigation/Feasibility Study (RI/FS) was conducted in a phased approach to determine the nature and extent of the contamination detected in OGV01, to identify possible sources of the contamination in groundwater, and to identify PRPs. The Phase I RI, begun in October 1999, evaluated existing data, collected additional data to narrow data gaps, determined the existence and location of contamination, and identified additional potential source areas. Area-wide sampling of private, commercial, and municipal wells, as well as springs and creeks, detected TCE and other volatile organic compounds (VOCs) in multiple wells and one spring. The information obtained during the Phase I RI provided additional data to better define the extent of the area-wide contamination.

The Phase II RI began in April 2002 and was completed in August 2005. The Phase II RI consisted of continued sampling of private, commercial, and municipal wells, as well as area springs. Additional field activities included investigating and sampling the OGV and Sullivan sanitary sewers, installing and sampling groundwater monitoring wells, and sampling possible additional source areas.

The data collected during the Phase II RI narrowed the data gaps and better defined the location and extent of the contaminant plumes. A FS and Proposed Plan were completed based on the conclusions of the Phase II RI. However, upon review, the EPA and MDNR decided additional site work was needed to fill in the remaining data gaps and to adequately define the OGV site. In order to fill in the data gaps, the OGV site was divided into two OUs:

- OU 1 consisted of the OGV wells, the Highway AF wells, and the area west and south of the OGV wells.
- OU 2 consisted of the closed Sullivan Landfill and/or other unknown potential source areas, wells and springs around the closed Sullivan Landfill, the Meramec River, and the La Jolla Spring Cave Complex.

Additional OU1 Investigations

The Post-Phase II RI (2005 to June 2007), which was a continuation of the Phase II RI investigation at OU1, included source area investigations and the additional characterization, installation, and/or completion of private, municipal, and monitoring wells. The additional field activities included sampling Winsel Creek and the Meramec River; characterizing OGV01; sampling OGV01 and OGV02; installing and sampling additional groundwater monitoring wells; sampling previously known potential source areas; and sampling possible additional source areas.

An Interim ROD for OU1 was signed on September 28, 2007. The Interim ROD included monitoring private wells in the areas of TCE contamination and providing an alternate water supply if a well was found to be contaminated with TCE above the Maximum Contaminant Level (MCL). No additional wells in the Oak Grove Village/Sullivan area have been found to be contaminated above the MCL since beginning the monitoring plan, which was designed under the Remedial Action and implemented in 2008.

After signing of the Interim ROD, the EPA continued efforts to fill data gaps identified for OU1 during previous site investigations. Several monitoring wells that were to be installed during the OU1 RI were not completed because of poor drilling conditions. Furthermore, several possible TCE source areas in the vicinity of OGV01 and OGV02 were not identified until the RI was nearly complete. In addition, the findings of the RI were inconclusive regarding the source of TCE contamination in the Highway AF Well Area.

The EPA's efforts to fill the data gaps consisted of various investigations performed by the U.S. Geological Survey (USGS). The investigations included sampling at eight additional potential source areas; installing and sampling one monitoring well; collecting air and groundwater samples at the La Jolla Spring Cave Complex; and collecting groundwater samples and measuring water levels at monitoring wells and private residential wells. Soil sampling and tree core samples showed that there was no indication that the additional areas investigated were sources of the TCE contamination.

After numerous investigations from 1987 through 2015, TCE contamination in OU1 was determined to be originating from the TRW/Ramsey facility, then transported through karstic features and the pumping of municipal wells to other areas in the Sullivan/OGV area.

TRW/Ramsey Facility Operations

From 1950 until 1983, TRW, Inc. (TRW) operated an automobile piston manufacturing facility at 300 Ramsey Street in Sullivan, Franklin County, Missouri. The site encompasses approximately seven acres. A chrome plating system was operated at the facility and various organic solvents and petroleum-based products were used. (TRW, Inc. is now known as TRW Automotive U.S.A., LLC.)

In 1983, TRW started performing voluntary investigations and remediation activities at the facility. On April 1, 1993, TRW and the current facility owners entered into an Administrative Order on Consent (AOC) with the EPA RCRA program. During the corrective action process, four interim measures plans were completed, which include the groundwater monitoring plan, the surface impoundments soils report, the drinking water contingency plan, and the pump and treatment plan.

The RCRA Facility Investigation (RFI) confirmed the presence of facility-related contaminants in groundwater above applicable groundwater regulatory guidance criteria, and assessed the horizontal and vertical extent of the groundwater contamination caused by releases from the former TRW facility. To date, TRW has installed a total of 41 monitoring wells at shallow (150 feet), intermediate (350 feet), and deep (550 feet) levels on and surrounding the facility property, and has conducted geophysical logging of the subsurface in selected monitoring wells. The RFI activities also determined that the primary contaminants of concern (trichloroethylene, 1,2-dichloroethene, 1,2-dichloroethane, lead and chromium) were present above applicable groundwater regulatory guidance criteria at various depths within the aquifer that serves as the water supply for the City of Sullivan. At present, there are no known completed exposure pathways to contaminated drinking water above regulatory standards associated

with this Site. There are potential future exposure pathways to the contaminated groundwater aquifers. The City of Sullivan and TRW both sample and monitor drinking water supply quality from the City of Sullivan's wells to assure that the water supply meets State Water Quality Standards. The City and TRW provide quarterly monitoring reports to federal and state officials.

Additional OU2 Investigations

The closed 28-acre Sullivan Landfill is owned by the City of Sullivan and is located east of Highway 185 and directly south of Emma Lane in a residential area. Adjacent to the landfill on the east is the Voss Meat Packing Plant. The landfill is approximately three miles north of downtown Sullivan and approximately 3,000 feet northeast of the OGV municipal wells. Other nearby wells include City of Sullivan Wells #9 and #10.

In 1970, the City of Sullivan began disposal of municipal and industrial wastes in an old ravine fill area. From 1970 to 1975, both industrial and municipal wastes were accepted in the ravine. The landfill was first permitted by MDNR in 1974.

Standard operations at the landfill ravine included crushing drums intact and/or pouring the contents of the drums into the ravine before crushing them.

In 1975, a plan was submitted to phase out the ravine operation and develop trench cells in the northern portion of the landfill. The ravine and trench fill areas were separated by an east-west ridge.

In 1978, MDNR issued a permit for trench-type disposal in an 8.5-acre area. In 1982, an additional 0.5-acre trench area was permitted by MDNR.

The trench fill area included the development of a series of shallow trenches approximately 25 feet wide and 200 feet long. During trench construction, the City included an industrial waste cell to store approximately 200 drums. Landfill records show that drums of barium chromate and TCE/oil and grease mixtures were deposited in the industrial waste cell.

The landfill ceased accepting wastes in 1983.

In August 1990, the City entered into an investigation with the USGS as a result of samples taken from the leachate collected at the Sullivan Landfill, as well as groundwater samples from several area wells, including OGV01, a former Sullivan municipal well, and the landfill monitoring wells.

During the investigation, USGS sampled three of the largest seeps from the Sullivan Landfill for VOCs and metals. Results indicated the presence of PCE from 8 to 19 µg/L and TCE from 150 to 370 µg/L. TCE degradation products, freons and other compounds were also detected.

In September 1990, MDNR issued the City a citation based upon available sampling results and the annual solid waste disposal facility inspections. In response to the MDNR citation, the City constructed berms around the cited seeps to help prevent off-site migration of leachate.

In October 1990, Sullivan issued a Notice of Liability letter to the Ramsey Corporation (owned by TRW, Inc.) and Meramec Industries as primary contributors of hazardous waste in the landfill. The

city estimated that TRW deposited 7,500 barrels of hazardous waste in the landfill and Meramec Industries deposited 356 barrels of hazardous waste.

After the City's Notice of Liability letters were mailed, a PRP group was formed to address contamination from the Sullivan Landfill. This group was comprised of TRW and the City of Sullivan. ABB-Environmental Services (ABB-ES) was contracted by TRW to conduct work at the Site on behalf of the PRP group.

In 1991, the Missouri Department of Geology and Land Survey performed five dye tracer tests in the Sullivan area. One of these tracers was injected into a sinkhole at the closed Sullivan landfill. The tracer was identified in La Jolla Spring 179 days after the tracer was released into the sinkhole.

In May 1992, prior to landfill closure, approximately 149 55-gallon drums and 32 5-gallon buckets that had been deposited in the industrial waste cell were removed by ABB-ES under contract with the PRP group.

The PRP group installed six monitoring wells at the landfill to determine if contaminants were migrating from the Site. The shallowest monitoring well (MW-105) was drilled to 177 feet below ground surface (bgs); the deepest monitoring well (MW-102A) was drilled to an approximate depth of 275 feet.

The City began construction of a landfill cap and associated leachate collection system in 1994. Construction was completed in 1995, and MDNR approved landfill closure in 1996.

Several contaminants, including TCE and Freon 11, have been detected in all six of the landfill monitoring wells (MW101, MW102A, MW102B, MW103, MW104, MW105) since their installation in 1992. TCE concentrations have been consistently detected from 0.5 µg/L to 6.6 µg/L, and Freon 11 has been detected from 1.4 µg/L to 197 µg/L.

The Voss well (354 feet deep), a private well located adjacent to the landfill, has had TCE detections during every sampling event since 2000 at levels ranging from 1.6 µg/L to 5.4 µg/L, and Freon 11 at levels from 15 µg/L to 120 µg/L.

Contaminants, including TCE, have been detected at depth within the landfill monitoring wells, indicating contamination underneath the landfill is deeper than 275 feet (the deepest monitoring well at the landfill) and could be impacting the area groundwater at depth.

In 2005, during the Phase II Remedial Investigation (RI) for the Oak Grove Village Well Superfund Site, MDNR drilled three deep monitoring wells. One of these wells was located 250 feet south of the Sullivan landfill. The well was drilled 501 feet bgs, for a total depth of 505 feet. The open annulus of the well is referred to as MW-1A and the deeper open-hole section below the riser from 349 to 505 feet bgs is referred to as MW-1.

In April 2006, MDNR took samples from MW-1A and MW-1. Both field analysis and laboratory results showed small concentrations of TCE and other contaminants in MW-1A. No concentrations were detected in MW-1.

During Phase I and Phase II of the RI, MDNR conducted periodic sampling of private wells near the landfill. Several contaminants, including TCE and Freon 11, were routinely detected in private wells located west of the closed Sullivan landfill. Two of these private wells had TCE detections above the MCL of 5 µg/L and were provided with whole-house filtration systems under an EPA removal action in 2001.

The detection of contaminants in MW-1A, the landfill monitoring wells, and nearby private wells indicates that releases at the landfill are impacting shallow groundwater in the upper aquifer. These contaminant releases have been detected in off-site wells, both west and south of the landfill.

In 2009, the EPA and TRW entered into an order to conduct a RI/FS at the landfill (OU2). The Phase 1 Site Characterization consisted of evaluating whether the landfill was a source of TCE in groundwater and sampling surface water and springs in the area to determine if they had been impacted by TCE via groundwater at the landfill.

Springs in the area around the landfill were sampled twice in May and October 2010. The only detection of VOCs was TCE at La Jolla Spring.

Two groundwater monitoring wells were also installed on the landfill surface. One was located next to a sinkhole in the middle of the landfill, and one to the northwest in the direction of private wells with known TCE detections. Groundwater sampling showed that both monitoring wells contained low levels of TCE.

La Jolla Caverns

La Jolla Spring is located approximately two miles east of the Sullivan Landfill and approximately four miles northeast of the TRW/Ramsey facility in Sullivan, Missouri. With a flow rate of approximately four cubic feet per second, the spring serves as a drainage point for the Sullivan and OGV areas.

The spring flows through Meramec Caverns, a large show cave owned and operated by a private owner that is open to the general public. The spring flows more than half a mile through the Cave Complex, and samples indicate that VOC concentrations in the spring decrease as the water flows through the Cave Complex.

Dye trace results from the 1990s, the size of the source needed to sustain the amount of TCE in the spring over many years, the size of the spring (e.g., its recharge area), as well as the suite of contaminants found in the cave air and the cave water show that a groundwater pathway exists from the Sullivan Landfill and the TRW/Ramsey facility to the La Jolla Spring Cave Complex.

Concentrations of TCE and several other VOCs have been detected in samples from La Jolla Spring since the early 1990s. Concentrations in spring water samples have ranged from less than 1.0 µg/L to 12.0 µg/L in samples collected by the USGS, MDNR, and a PRP consultant. Other VOCs detected have included cis-1,2-dichloroethene, Freon 11, Freon 12, and Freon 21.

From October 2002 to January 2005, the EPA and MDNR conducted six sampling events (air and water) in the La Jolla Spring Cave Complex. Sample results detected the presence of Freon 12; Freon 11; 1,1-dichloroethene; methylene chloride; cis-1,2-dichloroethene; trichloroethene; toluene;

m,p-xylene; 1,4-dichlorobenzene; PCE; ethanol; 2-propanol; and acetone. In the cave air, Freon 11 was detected as high as 270 kilograms per cubic meter ($\mu g/m^3$) and TCE was detected as high as 1,700 $\mu g/m^3$. Water samples within the La Jolla Spring Cave Complex detected Freon 11 as high as 2.13 $\mu g/L$ and TCE as high as 12.6 $\mu g/L$.

Air sampling conducted within the Cave Complex from March 2013 until November 2015 continued to show the presence of the same contaminants as were detected from 2002-2005. TCE was detected as high as 660 $\mu g/m^3$ in cavern air in October 2015.

The Missouri Department of Health and Senior Services (MDHSS) issued a Health Consultation regarding the TCE air concentrations in the cave air on December 12, 2014. The recommendations in the Health Consultation included the following: (1) inform workers of elevated TCE concentrations in the cave air and the potential health risks associated with TCE inhalation. DHSS recommended that notification be made as soon as possible; (2) implement permanent measures to mitigate vapor intrusion into the cave as soon as possible; (3) consider implementing temporary measures to prevent TCE exposure to female workers of childbearing age until permanent mitigation solutions are in place; and (4) once a permanent solution is in place, conduct periodic monitoring to confirm that mitigation solutions are effective in reducing contaminant levels.

In response to the MDHSS Health Consultation, the cave owner took the following measures: (1) employees were verbally notified of the TCE contamination; (2) a TCE fact sheet and other relevant health information provided by the EPA was posted in the employee break room; (3) employees were required to sign an employee handbook acknowledging that they were aware of the TCE contamination in the cave; (4) standard operating procedures were changed, such as having tour guides outside (weather permitting) or in the gift shop when not giving tours; (5) a temporary ticket counter was installed in the gift shop where concentrations of TCE were lower; and (4) worker rotations were adjusted so that women of child-bearing age were exposed as little as possible to the higher areas of TCE concentrations.

In March 2015, the EPA, the USGS and MDNR met with TRW to encourage TRW to work cooperatively with the cave owner to study ways to reduce TCE in the air and water within the cave. It was suggested that TRW implement specific actions as soon as practicable to reduce and/or eliminate the TCE in the air within the cave and gift shop. Some of the actions taken to date include upgrades to the existing heating, ventilation and air conditioning (HVAC) system to include a 10% fresh air exchange; installation of a set of temporary airlock doors to separate air in contact with the stream from the rest of the cave tour; thermal imaging to seal cracks and fissures contributing to the TCE escaping through the airlock doors; and enlarging the amphitheater entrance to increase air flow throughout the cave system. These actions had a significant impact on TCE concentrations on areas outside the airlock doors. However, it was determined that additional work and better controls were needed to ensure contaminant levels could be consistently maintained below a health-based level of concern.

Air sampling activities were performed within the cave and gift shop throughout 2015. The sampling results revealed that the efforts to date have not yet been successful in adequately mitigating the TCE air levels to the extent necessary to be protective of human health. On February 1, 2016, the Agency for Toxic Substances and Disease Registry (ATSDR) issued a follow-up letter to the 2014 Health Consultation. The ATSDR letter states as follows with respect to Meramec Caverns: **ATSDR recommends that exposures be stopped until such time as air TCE concentrations in the cave complex are consistently below a level of concern.**

Meramec Caverns voluntarily ceased cave tours in April 2016 until TCE concentrations can be decreased to below levels of health concern. In order for the tours to resume, TRW is taking further actions to lower TCE levels. Under the existing RI/FS order for OU2, TRW is currently performing the following actions: installation of a permanent airlock to replace the temporary airlock; improvement of the air-sealing and ventilation control at the main entrance; evaluation of the amphitheater entrance ventilation control; use of alternative wash water for cave maintenance; evaluation of the HVAC system; and a pilot test to evaluate the effectiveness of a ventilation borehole.

2. Physical location

The Site is located approximately 60 miles southwest of St. Louis in Franklin County along Interstate 44, and includes the cities of Sullivan, Oak Grove Village and Stanton, Missouri. The legal location of the Site is Section 4, Township 40 North, Range 2 West. The total population within four miles of the Site is estimated to be 6,800 persons.

3. Site characteristics

The Site consists of TCE groundwater contamination in a karst subsurface. The TCE contamination is discharging to a spring that surfaces inside the La Jolla Spring Cave Complex (a privately owned and operated show cave) outside of Stanton, Missouri.

4. Release or threatened release into the environment of a hazardous substance, or pollutant or contaminant

TCE has been found in groundwater and cave air above levels of health concern. TCE is listed as a hazardous substance pursuant to 40 C.F.R. § 302.4. As such, it is a hazardous substance as defined in Section 101(14) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. § 9601 (14).

5. NPL Status

The Site was listed on the NPL on September 5, 2002.

6. Maps, Pictures and other Graphic Representations

Two maps are attached. The first shows the entire Site, including the Cave Complex. The second map shows the areas of the cave that are being addressed under the removal action.

B. Other Actions to Date

1. Previous actions

During Phase I and Phase II of the RI, MDNR conducted periodic sampling of private wells near the landfill. Several contaminants, including TCE and Freon 11, were routinely detected in private wells located west of the Sullivan landfill. Two of these private wells had TCE detections above the MCL of 5 µg/L, and were provided with whole-house filtration systems under an

EPA removal action in 2001. The EPA is continuing maintenance of the filtration systems until a ROD has been implemented for OU2.

An Interim ROD for OU1 was signed on September 28, 2007. The Interim ROD included monitoring private wells in the areas of TCE contamination and providing an alternate water supply if a well was found to be contaminated with TCE above the MCL. No additional wells in the OGV/Sullivan area have been found to be contaminated above the MCL since beginning the monitoring plan, which was designed under the Remedial Action and implemented in 2008.

Remedial Investigations are ongoing at both OUs with final RODs planned within the next three years.

2. Current actions

Remedial investigations are ongoing at the Oak Grove Village Well OU1 and OU2 sites.

C. State and Local Authorities' Roles

1. State and local actions to date

State actions at the Site have included preparation of the Interim Record of Decision for OU1, continued involvement in reviewing investigative work for OU1 and OU2, and participating in community involvement activities.

MDHSS has been involved in human health risk assessments and health consultations.

2. Potential for continued state/local response

MDNR is expected to continue to be involved in the monitoring and review of Site activities. MDHSS is expected to continue to be involved in evaluating human health risks associated with TCE exposures.

III. THREATS TO PUBLIC HEALTH, OR WELFARE, OR THE ENVIRONMENT, AND STATUTORY AND REGULATORY AUTHORITIES

The Site conditions pose a significant threat to public health and welfare and meet the criteria for a response action under 40 C.F.R. § 300.415(b)(2) of the National Contingency Plan (NCP), and are described as follows:

300.415(b)(2)(i) – Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants.

TCE has been detected in cave air and in the local groundwater system. Exposures to TCE in groundwater have been addressed through the implementation of air strippers on public water supply wells and the use of whole-house filtration systems on two private wells with TCE concentrations above the MCL of 5 ppb. Although there are no known unacceptable TCE exposures occurring in groundwater,

sampling has indicated that past and present TCE air concentrations inside the La Jolla Spring Cave Complex pose significant risks to human health for both short- and long-term exposures.

TCE is a man-made chemical that is widely used as a cleaner to remove grease from metal parts. TCE is a nonflammable, colorless liquid with a sweet odor. Exposure to TCE at very high concentrations (particularly in closed, poorly ventilated areas) may cause headaches, lung irritation, dizziness, poor coordination, and difficulty speaking. As of 2011, following the EPA Guidelines for Carcinogen Risk Assessment, TCE is characterized as "carcinogenic to humans" by all routes of exposure. This conclusion is based on convincing evidence of a causal association between TCE exposure in humans and kidney cancer. The kidney cancer association cannot be reasonably attributed to chance, bias, or confounding. The human evidence of carcinogenicity from epidemiologic studies of TCE exposure is strong for non-Hodgkin's lymphoma (NHL), but less convincing than for kidney cancer, and more limited for liver and biliary tract cancer. Adverse non-cancer effects associated with TCE exposure by inhalation include hepatic, renal, neurological, immunological, reproductive, and developmental effects. The most sensitive observed non-cancer effects are those affecting the immune system and the developing fetus.

Historically, TCE concentrations in cave air have been as high as 1,700 $\mu g/m^3$ in October 2003. More recent sampling has detected TCE as high as 660 $\mu g/m^3$ in October 2015. TCE concentrations are highly variable and are based on the differences between the outside air temperature and the temperature inside the caverns.

Individuals working in the cave have been exposed to TCE concentrations significantly greater than levels of health concern protective for long-term non-cancer effects such as immune and kidney effects (8 $\mu g/m^3$) and for short-term developmental effects (6 $\mu g/m^3$). When evaluating non-cancer health effects, a hazard quotient greater than 1 indicates unacceptable risks. The HQs for cave workers significantly exceed 1 for non-cancer health effects for both short- and long-term exposures. Potential risks to tour guides are greater than other types of human receptors, such as gift shop workers or visitors, due to the length of the time they spend in the back portions of the cave, where higher TCE concentrations have been detected.

300.415(b)(2)(ii) – Actual or potential contamination of drinking water supplies or sensitive ecosystems.

TCE has been detected in cave air and in the local groundwater system. Exposures to TCE in groundwater have been addressed through the implementation of air strippers on public water supply wells and the use of whole-house filtration systems on two private wells with TCE concentrations above the MCL (5 ppb). Although there are no known unacceptable TCE exposures occurring in groundwater, sampling has indicated that past and present TCE air concentrations inside the La Jolla Spring Cave Complex pose significant risks to human health for both short- and long-term exposures.

IV. ENDANGERMENT DETERMINATION

Actual or threatened releases of hazardous substances from the site, if not addressed by implementing the response actions selected in this Action Memorandum, may present an imminent and substantial endangerment to public health, or welfare, or the environment.

V. PROPOSED ACTIONS AND ESTIMATED COSTS

A. Proposed Actions

1. Proposed action description

The proposed removal action for cave air at the Site is to use effective and sustainable engineering alternatives to reduce TCE concentrations inside the gift shop and in portions of the cavern utilized by visitors and workers so that no human receptors are exposed to TCE concentrations above a level of health concern.

The following actions will be performed to reduce TCE concentrations in the cave and gift shop:

1. Two ventilation wells will be installed on the main trunk of the cave system upstream of the Jungle Room. The vent wells will be outfitted with blowers at the ground surface designed to withdraw air from the cave. The operation of the blowers may vary depending on weather conditions. The purpose of the system is to capture and vent air that has migrated through the cave before it reaches the developed portion of the cave.

2. An evaluation will be conducted of the HVAC system in the gift shop to determine whether appropriate modifications are necessary to reduce the amount of cave air entering the gift shop building. This evaluation will be provided no later than November 1, 2016, after the ventilation wells have been pilot tested and are fully operational or sooner.

3. Portable air cleaners will be installed in the gift shop area, and the area between the gift shop and the air lock doors. The cleaners will treat the air in these areas to remove TCE. The continuing operation of these cleaners will be evaluated as work is completed, and may continue as necessary.

4. The existing air lock doors will be upgraded and a signal system installed to indicate whether one or both doors are open to avoid accidental simultaneous openings of both sets of doors.

5. An alternative source of water will replace the use of contaminated spring water for cleaning and maintaining the cave features.

During and after completion of these mitigation activities, sampling will be conducted to determine what affect these actions are having on TCE concentrations in the developed portion of the cave. If additional actions are necessary to reduce TCE concentrations, this Action Memorandum may be amended.

After mitigation efforts are completed, confirmation sampling will be conducted to assure that the planned air control measures have resulted in a sustainable decrease in TCE concentrations below a level of health concern for cave workers and visitors. For an 8.5-hour period of exposure, the level of health concern is 6 $\mu g/m^3$, which is protective for all types of cancer and adverse non-cancer health effects associated with TCE. The number of consecutive sampling events required to demonstrate this decrease in TCE levels before re-opening the cave will be determined at a later date and will be based on the monitoring data collected, as well as the time of year.

Once data have demonstrated that the planned air control measures have effectively resulted in a sustainable decrease in TCE concentrations in the cave below a level of health concern, additional sampling will be needed to ensure continued protection of human health. The length of this confirmatory sampling period will be contingent upon the monitoring results.

2. Contribution to remedial performance

In the event that future remedial action at the Site becomes necessary, this action is expected to be consistent with such action, to the extent practicable.

3. Description of alternative technologies

Not Applicable.

4. Engineering Evaluation/Cost Analysis

Not Applicable.

5. Applicable or Relevant and Appropriate Requirements (ARARS)

All applicable or relevant and appropriate requirements of Federal and State law will be complied with to the extent practicable after the engineering solutions for addressing the contamination have been identified. A letter dated April 19, 2016, was sent to the state requesting that ARARs be identified for the Site. Any state ARARs identified in a timely manner for this removal action will be evaluated by the EPA and complied with to the maximum extent practicable.

No hazardous wastes are expected to be generated, treated or transported. TCE concentrations that are vented from cave air to the outside atmosphere are not being vented at higher concentrations; they are being redirected from utilized areas of the cave. The surface vent location is on secluded private property where no human receptors are located. In addition, any VOCs that may be emitted are expected to naturally photo-degrade in the atmosphere over a period of days.

6. Project Schedule

Primary on-site activities are expected to take less than one year to complete; a detailed schedule has been developed and will be modified as work continues.

B. Estimated Costs

This action is expected to be performed by the PRPs pursuant to an administrative consent order. Therefore, no cost estimates are provided for actions conducted by the PRPs. Costs for oversight and confirmation of the PRPs' actions are estimated to be $50,000.

VI. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

Delayed action will result in prolonged suspension of business operations until such time as TCE exposures inside the gift shop and cavern no longer pose a risk to public health.

VII. OUTSTANDING POLICY ISSUES

None.

VIII. ENFORCEMENT

The PRPs are known, as identified above in Section I. Work is currently being performed under the 2009 RI/FS order. A consent order for a CERCLA 106 removal action will be negotiated with TRW and/or the other PRPs, or consideration will be given to the issuance of a unilateral order(s) if necessary to implement the required removal actions.

IX. RECOMMENDATION

This decision document represents the selected PRP-lead, time-critical removal action for the Oak Grove Village Well Site located in Franklin County, Missouri, developed in accordance with CERCLA, as amended, and not inconsistent with the NCP. The decision is based upon the administrative record for the Site.

Conditions at the Site meet the criteria set forth at 40 C.F.R. Section 300.415(b)(2) for a time-critical removal action, and I recommend your approval of the proposed PRP-lead removal action.

Approved:

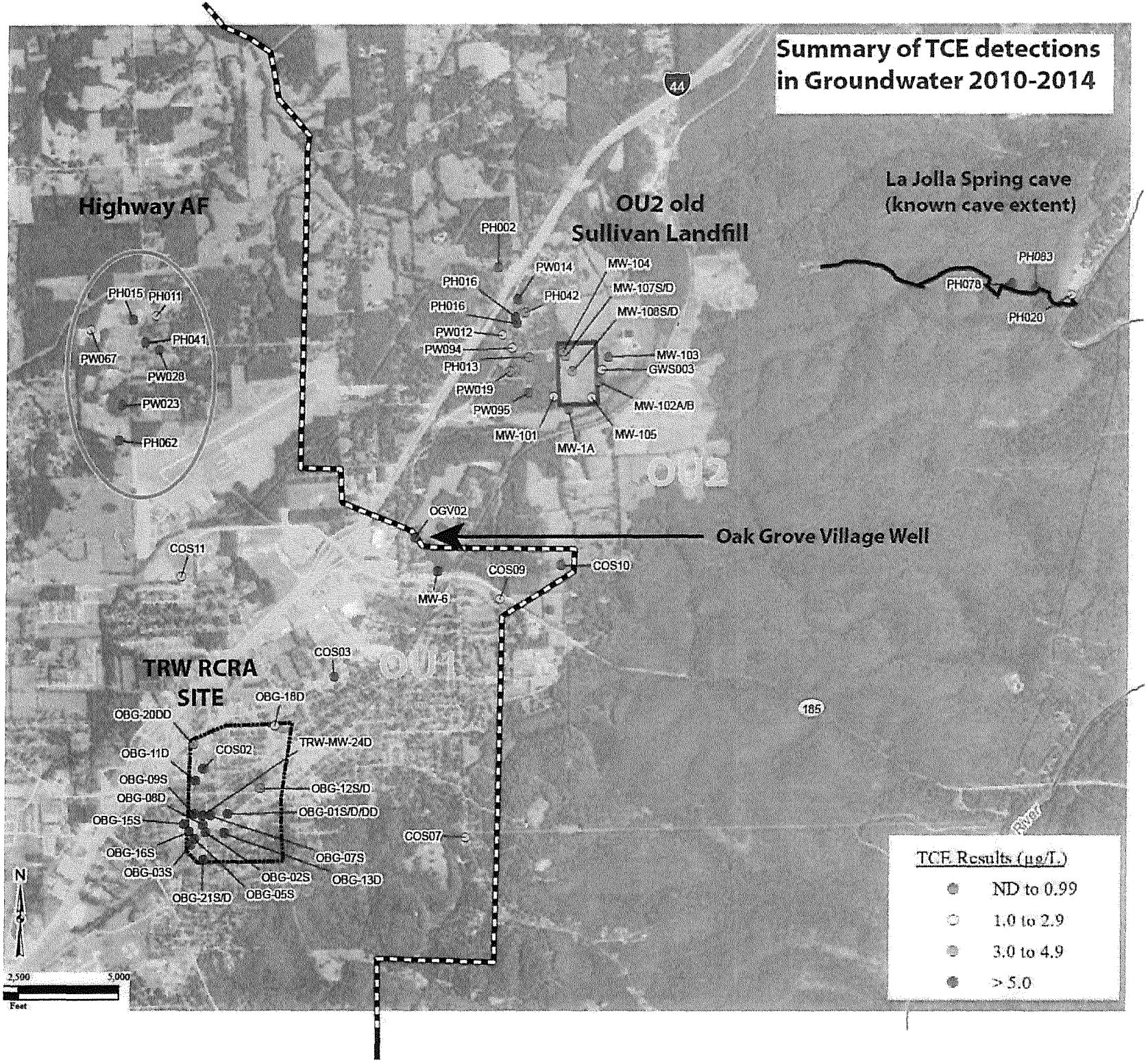
Mary P. Peterson

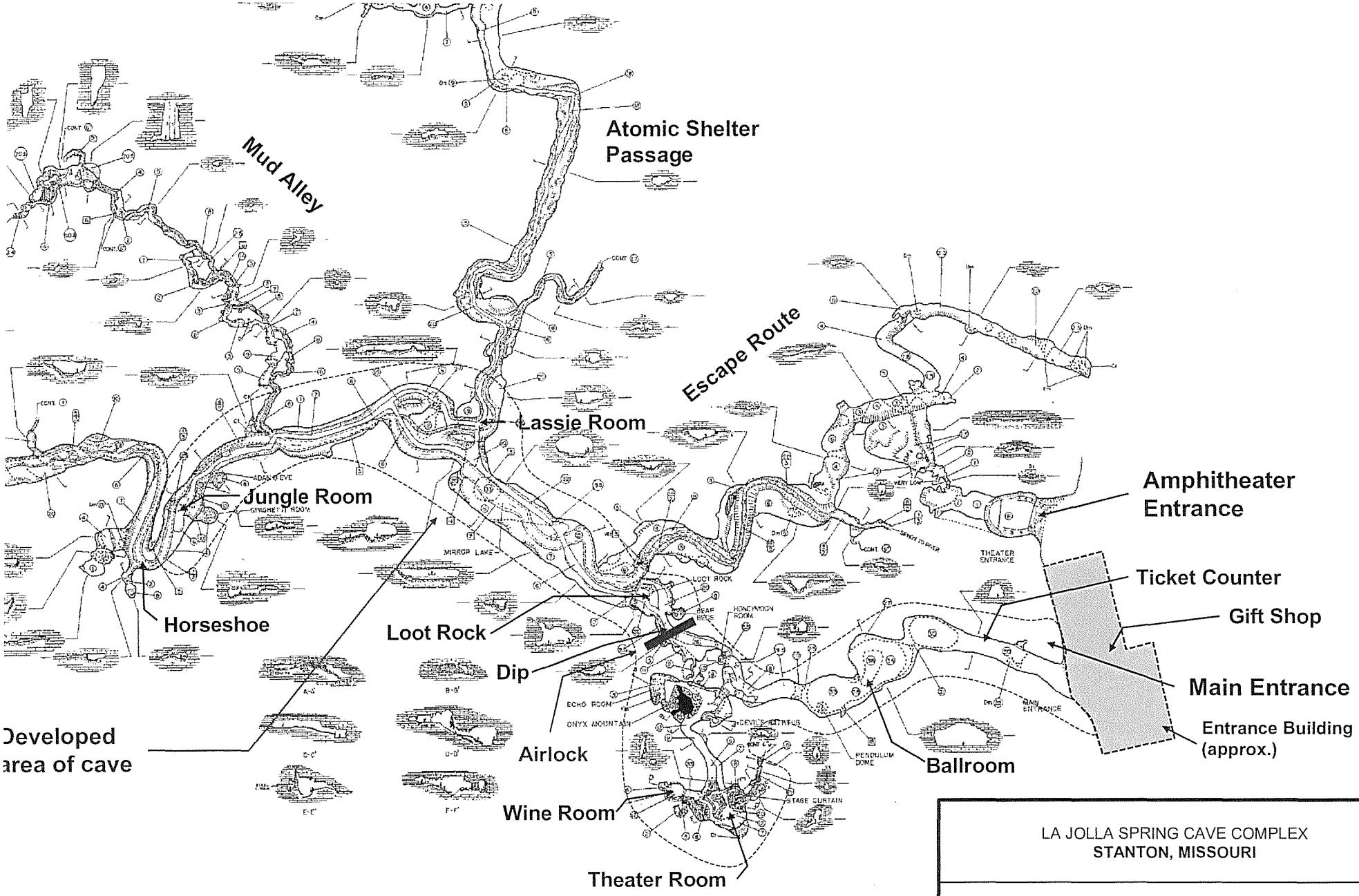
Mary P. Peterson, Director
Superfund Division

7/19/2016

Date

Attachments: Site Maps (2)


Summary of TCE detections in Groundwater 2010-2014
Highway AF
OU2 old Sullivan Landfill
La Jolla Spring cave (known cave extent)
PH083
PH078
PH020
PH002
PW014
MW-104
PH016
MW-107S/D
PH042
PH016
MW-108S/D
PW012
PW094
MW-103
PH013
GWS003
PW019
PW095
MW-102A/B
MW-101
MW-1A
MW-105
PH015
PH011
PH041
PW067
PW028
PW023
PH062
OU2
OGV02
Oak Grove Village Well
COS11
COS09
COS10
MW-6
COS03
TRW RCRA SITE
OBG-18D
OBG-20DD
TRW-MW-24D
OBG-11D
COS02
OBG-09S
OBG-12S/D
OBG-08D
OBG-01S/D/DD
OBG-15S
COS07
OBG-16S
OBG-07S
OBG-03S
OBG-02S
OBG-13D
OBG-21S/D
OBG-05S
185
River
N
2,500
5,000
Feet
TCE Results (µg/L)
ND to 0.99
1.0 to 2.9
3.0 to 4.9
> 5.0



LA JOLLA SPRING CAVE COMPLEX
STANTON, MISSOURI

CAVE LAYOUT

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1