US Magnesium Superfund Site Documents
Annotated Bibliography
2016 – 2017

This bibliography describes existing documents organized by topic. Within each topic are multiple documents. Each document is summarized in a brief statement. Additional detailed information is provided in an outline formatted to match document structure with solid bullets indicating document section titles and open bullets providing pertinent content.

Phase 1A

1. Phase 1A RI SAP- Remedial Investigation Sampling and Analysis Plant to Identify Chemicals of Potential Concern in Soils, Sediment, Solid Waste, water, and Air, and Receptor Surveys PRI Areas 2 and 8 through 17

Phase1A_PRIs2&8-17_RI_SAP (281 pages, 2013)

Remedial investigation (RI) and sampling and analysis plan (SAP) for preliminary remedial investigation areas (PRIs) 2 and 8 through 17.

- Preface
  - US Mag produces ~60,00 metric-tons Mg/year and ~30 million-gallons of pure Cl liquid.
  - Water releases include:
    - Highly acidic liquid and slurry streams with HCB, PCBs, and dioxins/furans;
    - Liquid and gaseous releases of Cl gas and HCl as well as particulates/aerosols containing chlorinated organic compounds.
- Section A: Project Organization (SAP worksheets 2-9)
  - SAP identifying information
    - EPA Region 8 is the lead agency for the project.
    - Preliminary demonstration of methods applicability (DMA) - Remedial Investigation (RI) scoping revealed that acidic conditions on Site poses unique challenges:
      - Collection
      - Chemical analyses of complex matrices
    - Outline of phases:
      - Phase 1A: COPC and Receptor-Exposure Investigation
      - Phase 1B: Preliminary Nature and Extent Investigation
      - Phase 2: Detailed RI, Feasibility Study (FS) screening, and Extent Investigation
      - Phase 3: FSs
      - Phase 4: Remedial Response decision
  - Distribution list: Names, titles/roles, affiliation, and contact information
  - Personnel sign-off sheet: signifies that personnel have read and understood Phase 1A RI SAP
  - Project organizational chart
  - Communication pathways
  - Personnel: responsibility and qualifications
  - Special personnel training requirements
  - Joint project planning session and participation sheets
- Section B: Preliminary Conceptual Site Model and Problem Definition
  - Identifies information necessary to begin evaluating the nature and extent of contaminants, fate and transport pathways, and estimated risk to human and ecological receptors.
  - Introduction:

- Site location
- Plant built within an area topographically higher than surrounding GSL shoreline.
- Outlines the different areas of the Site (just a few are mentioned below).
    - Old Waste Pond- also called the Northeast Ponded Waste Lagoon or Inactive Waste Pond.
        - 8834 acres
        - Received wastewaters via Main Ditch from 1972 through 1986.
        - April 2012- shoreline-berm adjacent to the Southeast Ponded Waste Lagoon (Active Waste Pond) was breached.
        - DMA measured pH of 5.37, with volatile organics and haloacetic acids.
            - Suggests seepage from active waste pond
    - Surface and groundwater- Shallow groundwater across the site is likely in communication with wastewater in the ditches and waste lagoons

- Site setting: Outlines site features including geology, hydrogeology, water chemistry, and climate conditions
    - Desire to examine:
        - How surface features/hydrology affect flow of waste streams and surface water.
        - Whether porous oolitic sand and less permeable Lake Bonneville-related silts may impact groundwater flow and contaminant transport at Site.
        - Potential for highly acidic wastewater from Plant to dissolve carbonate oolitic sands and create preferential pathways for contaminant release and migration away from ponded waste lagoons.
    - Surface features and hydrology
        - Dominated by two features:
            - The GSL
            - Man-made features: ditches evaporation ponds, and ponded waste lagoons
        - Additional intermittent flow of surface runoff from either Tempie Springs or Skull Valley.
    - Geology: Site underlain by alternating fine-grained lake silts and very porous and permeable oolitic sands, sometimes mixed with alluvial sands and gravels.
    - Site-specific soil types: Primary soil type is described as the Skumpah-Yenrab complex composed of loamy fine sand and fine sand.
    - Hydrogeology:
        - Groundwater:
            - Shallow unconfined aquifer- only aquifer being investigated on site
                - Potential recharge from precipitation, groundwater underflow from infiltration due to precipitation on surrounding mountains, upward leakage from lower layers, and wastewater infiltration.
                - Groundwater mound beneath site (2004 maps)
                - Horizontal hydraulic conductivity of oolitic sand averages 19 ft/day (range 14-30 ft/day).
                - Horizontal hydraulic conductivity of silty sand averages 0.75 ft/day (range 0.72 to 0.77 ft/day).
                - Upward vertical hydraulic gradient of 0.71 to 11.48 ft/ft.
                - Largest upward gradient at northeastern portion of the site.
            - Groundwater and wastewater interactions

        - The surface wastewater contributes to shallow groundwater near the ditches and ponds during periods of high wastewater levels (downward vertical gradient) (MWH 2005 potentiometric data).
        - Southeast trending lobe during fall in the southern portion of the Southeast Ponded Waste Lagoon suggests local flow of wastewater into groundwater.
        - Standing water near PRI 5 in Buffer Area South suggests seepage from active waste lagoon.
    - Surface water- outlines all surface water features on the site
        - During site field visits EPA observed sinkhole-like features, possibly resulting from dissolution of carbonate oolitic sand in the area north of the Northwest Ponded Waste Lagoon.
- Water chemistry:
    - Groundwater ion chemistry varies from brackish to saline water.
    - MWH provides Stiff diagrams with ion concentration at various sites.
- Climate:
    - Wind direction trends from north to northwesterly across the site, with Pacific-driven westerly flows.
        - Daily changes occur due to thermal convection and intermittent northeasterly flows, sporadic microclimate multi-vector breezes, and seasonal wind shifts.
        - Temperature
- Nature and extent of contamination
    - Soil and sediment contamination: Primary contaminants of interest in the soil and sediment are PCDDs/PCDFs, PCBs, and HCB.
        - Provides concentration ranges measured on site.
        - HCB is the most prevalent overall contaminant- concentrations >1ppm in majority of historical samples collected in Active Waste Lagoon and Gypsum Pile.
        - DMA includes 15 surface soil samples from PRI 1, 4, 5, 6, 7, 9, 14, and 16
            - Higher concentrations of PCBs in PRI 1, 4, 5, 6, 7
            - Higher concentrations of PCDDs/PCFs, HCBs in PRI 1
    - Groundwater contamination: Limited detections of HCB, PCDDs/PCDFs, SVOCs, and trace metals.
        - Brackish to saline water: TDS ranges from 7,280 to 226,000 ppm
        - Alkalinity ranges from 96.2 to 978 ppm
        - Density ranges from 1.00 to 1.17 g/mL
        - pH ranges from 6.42 to 7.12
        - Negative Eh indicates slightly reducing environment
        - Nature and Extent:
            - HCBs in isolated areas: 0.41 to 3.0 ppb
            - PCDDs/PCDFs in isolated areas: low concentrations
            - Localized VOC plume with TCE underlies Site
        - Fate and Transport:
            - COPCs have long half-lives, evaporate from soil or water very slowly, resistant to chemical reaction.
                - Compounds bond tightly to soil. It was estimated that compounds migrate in groundwater at rates 7,600 (dioxins) and 960 (HCBs) times slower than groundwater.

        - Absence of PCBs and other hydrophobic compounds may be due to separation of waste water from groundwater by thin (~10ft) clayey silt layer.
    - Air releases containing Cl gas, HCl, and other hazardous substances
        - Stack Emissions: six individual stacks on site
        - (CRB) Chlorine Reduction Burner treats Cl gas before release
            - Stack testing indicates 98-99% efficiency
            - Annual shutdown and periodic maintenance/malfunctions result in untreated Cl gas. Amounts reported to UDEQ- AQD.
        - Bypass mode: anode gas steam from electrolytic cells are scrubbed with CRB
        - Title V operating permit: 3,300 ton/year Cl gas, additional 7,500 tons/60 months is allowed for maintenance, fugitive emission of 75 tons/year Cl gas
            - Discharge of HCl not included in the permit
        - Historical monitoring: indicates 8-hour average HCl 220 ug/m3
        - Modeling output may be more useful than measurements due to output variability
    - Contamination in biota
        - PCDDs/PCDFs, PCBs, and HCBs can bioaccumulate in tissues of organisms and food chain
        - Dioxin/furan tissue concentrations range from 0.02-3 ppb with highest level in mice living near sanitary lagoon
        - Plants and invertebrates from sanitary lagoon most highly contaminated (thousands of times higher than reference samples)
        - Bird eggs collected from the site had elevated (compared to reference samples) PCDDs/PCDFs, PCBs, and HCBs
- Risk assessment findings reported by others
    - Previous Human Health Risk Assessments
        - MWH(2005c) Calculated cancer risk to on-Site workers and an off-site rancher
            - Estimated low risk from ingestion of beef grazing near site
            - High risk ingestion of beef grazing near Main Ditch
        - DeGrandchamp (2007)
            - Cancer risk for workers was calculated for exposure to concentrations Central Ditch, Chlorine Ditch, Main Ditch, and Old Waste Pond.
            - Concluded that cancer risk for workers was a concern (risk > 1E-4) at locations near the facility.
        - ChemRisk (2007) Finley Expert Report
            - Calculated both cancer and non-cancer risks from Site-related contaminants.
            - Concluded that risk to current workers was below a level of concern for cancer (risk < 1E-4) and non-cancer (HQ<1).
    - Previous Ecological Risk Assessments
        - Parametrix (2004)
            - Main source of risk were chromium, dioxin, and HCB.
            - Confidence in predicted risks to invertebrates, vegetation, microbes and terrestrial invertebrates is “very uncertain” with current data.
            - Mammalian and avian risk receptors were characterized as “considerable.”
        - Stratus (2007)
            - Plants, terrestrial and aquatic invertebrates, mice, and bird eggs are more highly contaminated with PCDDs/PCFs, PCBs, and HCB than reference areas .

        - Many birds were observed coming into contact with ditch or pond water.
    - Berger Diagrams for Human and Ecological Receptor Exposure also referred to as CSM or pathway receptor network diagram
        - Fate and transport processes that may result in migration of contaminants in the environment and the routes and pathways by which human and ecological receptors may be exposed to site related contaminants.
        - Exposed populations
        - Exposure routes
        - Ecological exposures
    - Information and data gaps and needs
        - CERCLA releases: manner, type, location and chemistry
        - Hydrogeology
            - Pathways created from dissolution of carbonate sands,
            - Mixing between groundwater and surface waters
            - Mounding
        - Nature and extent of contamination
            - Groundwater, surface water, air, soil/sediment
        - Human health pathways and exposure scenarios
        - Ecological habitats and species
        - Data from past investigations
- Section C: Data quality objectives (DQO)
    - Project quality objectives and sampling strategy
        - Obtain sufficient data to support identification of COPCs for human and ecological receptors
        - Acquire human receptor exposure information
        - Identify and map ecological habitats for evaluating potential eco-receptor exposures
    - DQO for COPC in soil/sediment/solid waste
        - Not expected to fluctuate seasonally
        - Plan to obtain data. Includes coring from surface to depth of native soil
        - Target sampling locations: 14 unbiased samples in each PRI chosen randomly from a grid
        - Methods on collection and processing samples
    - DQO for COPC in water
        - Known to change seasonally, so will be sampled more than one time per year
        - Groundwater: 27 locations (19 existing wells and 8 new wells) 2 new wells will be nested
            - Monitored monthly for groundwater elevation
    - DQO for COPC in air
        - Concern for both long-term and short-term exposures
        - Radius of 5 miles around site
        - Sampling over many months at different stations versus intense sampling over short period of time.
            - Study design in Phase 1B
        - Air modelling with AERMOD
    - DQO for human health survey
        - Derive reliable quantitative estimates for exposures

        - Inhalation, oral/dermal, and beef/game
        - Human health surveys
    - DQO for ecological habitat survey
        - Identify and map various categories of terrestrial and aquatic habitats on site
- Section D: Sampling and Analysis- Worksheets 12-21
    - Measurement and performance criteria
        - Concern that contaminated media will have characteristics that negatively affect analytical performance (high salinity, low pH, high levels of many contaminants).
    - Secondary data criteria and limitations- table of historical data from Site and its use and limitations
    - Summary of project tasks
        - Overview of Phase 1A
        - DMA for soil/sediment/solid waste, water, and air
        - Geophysical survey
        - Phase 1A Field Tasks
            - Approaches for characterizing soil/sediment/soil waste
                - Information on boring depths
            - Groundwater and surface water
                - More information on wells
        - Human health exposure and ecological habitat surveys
            - To be completed collaboratively between US Mag/ERM and EPA
        - QA/QC for equipment decontamination, management of investigation-derived waste
        - Field documentation- data packages, generated reports
        - Data validation
        - Sampling site locations and rational for how site was chosen (Worksheet 14)
    - Reference limits and evaluation- Identifies target quantitation limits and method detection limits for each analyte and each medium.
        - Solid media
        - Aqueous matrix
        - Air
    - Project schedule/timeline
    - Sample collection
        - Process design
        - Sampling procedures: soil/sediment/solid waste, groundwater, surface water, air and general SOPs
        - Sampling locations
        - Analytical SOPs
- Section E: Quality Assurance
    - Field equipment calibration, maintenance, testing, and inspection
    - Analytical SOP references
    - Instrument calibration, testing, maintenance, and inspection
    - Sample handling and custody requirements
    - Analytical data validation
    - Usability assessment for precision, accuracy, representativeness, completeness
- Worksheet 3: Distribution list
- Worksheet 4: Personnel sign off sheet

- Worksheet 6: Communication pathways
- Worksheet 7: Personnel responsibility and qualifications
- Worksheet 8: Special personnel training requirements
- Worksheet 9: Joint project planning session participants sheet
- Worksheet 10: Conceptual site model and problem definition
- Worksheet 11: Project quality objectives and sampling strategy
- Worksheet 12: Measurement performance criteria
- Worksheet 13: Secondary data criteria and limitations
- Worksheet 14: Summary of project tasks
- Worksheet 16: Project schedule/timeline
- Worksheet 18: Sampling locations and methods/SOP requirements
- Worksheet 19: Analytical SOP requirements
- Worksheet 20: Field quality control sample summary
- Worksheet 21: Project Sampling SOP references
- Worksheet 22: Field equipment calibration, maintenance, testing, and inspection
- Worksheet 23: Analytical SOP references
- Worksheet 24: Analytical Interment Calibration
- Worksheet 25: Analytical instrument and equipment maintenance, testing, and inspection
- Worksheet 26: Sample handling system
- Worksheet 28: Laboratory QC samples
- Worksheet 29: Project documents and records
- Worksheet 30: Analytical services
- Worksheet 31: Planned project assessments
- Worksheet 32: Assessment finding and corrective action response
- Worksheet 33: QA management reports
- Worksheet 34: Verification Process
- Worksheet 35: Validation Process
- Worksheet 36: Analytical data validation summary

2. Phase 1A Data Report for PRI Areas 2 and 8-17

Phase1A_PRIs2&8-17_DataReport (45 pages, 2015)

Data report for PRI areas 2 and 8 through 17.

- Introduction
  - Results are from sampling campaign laid out in Phase 1A to select COPCs.
  - Data will also be used for a screening level risk assessment (SLRA) described in the SLRA Technical Memorandum.
- Background
- Pre-Phase 1A Reconnaissance Activities
  - Cultural Resources Survey
    - Conducted by a BLM-certified professional archeologist from Logan Simpson Design Inc.
    - Twenty-seven sample locations were surveyed in PRI Areas 8, 15, and 16.
    - The BLM approved sampling in these locations in October 2013.
  - Reconnaissance Grain Size Activities
    - Grain size analysis was conducted at selected sample sites laid out in SAP Worksheet #11.

        - It was determined that fines fraction analysis is not necessary for PRI Areas 15 and 16.
    - Landfill Geophysical Survey
        - The objective of the survey was to measure the depth of the landfill, identify large metal objects/debris, locate subsurface sampling locations, and evaluate trenching versus drilling methods.
        - Four electrical resistivity screens were conducted.
        - Depth to native soil is approximately 25 ft.
        - ERM recommended that sonic drilling is more effective than trenching.
- Phase 1A Field Investigation Activities
    - Surface Solids Sampling
        - Sampling locations can be found in SAP Worksheets #14 and #18.
        - Field quality control samples were also collected.
    - Subsurface Solids Sampling
    - Monitoring Well Installation and Development
    - Water Sampling
    - Staff Gauge Installation
    - Water Level Measurements
    - Surveying
    - Survey of Surface Water Extent at PRI Area 8
- Phase 1A Sample Analysis and Data Management
- Phase 1A Investigation Results
    - Surface and Subsurface Solids
    - Surface Water and Groundwater
    - Bulk Versus Fine Analyses of Surface Solids
- Quality Control Activities

3. Phase 1A RI SAP Surface Water Addendum

Phase1APRIs2&8-17_RI_SAP_SW_Addendum (158 pages, 2016)

Surface water sampling as a part of Phase 1A remedial investigation (RI) and sampling analysis plan (SAP).

- Introduction
    - Surface water sampling of PRIs 1 and 3 was postponed until the resolution of the RCRA settlement.
- May and July 2015 Phase 1A surface water sampling activities
    - Surface water sampling
        - Sample locations are listed in SAP worksheets 14 and 18 in Figure 1 and Table 1.
        - Samples were taken in PRIs 1,3,5, and 6.
    - Quality control samples
        - Includes field duplicates (10%) and trip blanks (one per day).
    - Phase 1A sampling and analysis plan and field modifications
        - SAP was updated with current laboratory accreditations.
        - Additional sample sites within the Skull Creek Diversion Ditch (due to indications of wastewater seepage**)**, the Star Pond Overflow Ditch, and a former wastewater ditch were identified.
        - Pentachlorobenzene was added as an SVOC analyte. Protocol for splitting and 0.2 □m filtering of perchlorate surface water samples was terminated.

        - The selective ion method was selected for 1,4-dioxane because it provides a lower detection limit compared to the previous method.
        - Silicone tubing was approved for use in the field. Sample locations in the Main Ditch and Sanitary Lagoon were adjusted.
- Phase 1A surface water sample analysis and data management
    - Laboratory analyses
    - Data validation
        - Presented in SAP worksheet 36
        - Stage 2B data validation was conducted on 90% of the samples. Stage 4 data validation was conducted on 10% of the samples by a third party contractor.
    - Data management
- Phase 1A surface water investigation results
    - Table 2 includes the number of samples collected, number of detections and percent detected, the minimum, maximum, and average detected concentrations, the minimum and maximum detection limits for no-detect results, and the sample location corresponding to the maximum detect.
    - Table 3 is a summary of all surface water results.
- Quality control activities
    - Project assessments and corrective actions
        - A corrective action report (CAR) was issued to account for multiple dilutions of samples that are to be analyzed for PCB (details are in Appendix G of the Phase 1A Data Report).
    - Data usability assessment
        - Method quality objectives are outlined in SAP Worksheet #37.
        - The surface water sample results qualified (less than 0.25% exceedance).
        - Holding times were exceeded for some samples in analyses for anions, Cr VI, perchlorate, VOCs, SVOCs, PAHs, and TOC.
        - The majority of accuracy issues are related to matrix issues and high concentrations.
        - Approximately 1% of the total results were rejected due to accuracy issues.
        - 98% of samples from Phase 1A are considered valid.
    - Data adequacy
        - One hundred and thirty-seven of the analyte data sets are adequate for COPC/COPEC selection. Thirty-nine of the analyte data sets have uncertainty regarding their adequacy, the majority of which are SVOCs.
        - More than half of the 39 data sets that have uncertainty had undiluted samples that exceeded the lowest screening level.
- Appendix A SAP and field modification forms
    - The Skull Valley Diversion Ditch (SVDD) was added to the sampling list due to the presence of wastewater seepage.
- Appendix B Field documentation
- Appendix C Laboratory reports
- Appendix D Data validation reports
- Appendix E Response to agency comments

4. Scoping Meeting Agenda- Session 1

Scoping_Meeting_Phase1A_RI_2011 (8908 pages, 2011)

- Decision Logic Diagram: Historic- & Ph1-Data Integration Process
- Scoping meeting 1
  - Session 1 – Presentation by ERM to US Mag, EPA, UDEQ, USFWS
    - Agenda for 11/28/2011 to 11/20/2011
    - Day 1:
      - Scoping meeting is the first step in development of SAP for each phase of remedial investigation (RI)
      - Rationale and Objective for PRI Designations
      - Rationale and Objective for Phase 1 Sampling and Analysis Plan (SAP)
      - Site Setting
      - Fate and Transport Conceptual Site Model (CSM)
        - Visual of fate and transport of contaminants on and from US Mag (page 19)
    - Day 2:
      - Secondary Data Usability
        - Evaluation of historical measurements from the site
      - Human Health (HH) and Ecological Screening Values
        - ATSDR and USEPA RSL
          - Most conservative benchmark (by media) used to screen analytical detection limits
      - Review of Historic and Current US Mag Operations
        - Process modifications have not resulted in significant changes to contaminants of potential concern (COPCs) historically detected on site
      - COPCs, Potential Pathways, and Receptor Populations
      - PRI-Specific CSMs
        - For each PRI gives HH CSM, Eco CSM, and historical data
    - Day 3:
      - Background/Ambient Concentration Considerations
        - Compounds that are elevated above background concentrations should be remediated below background concentrations
      - DQO Overview
        - Seven-step process to obtain data starting with stating the problem
      - Review of Major Outcomes and Action Items
      - Review Draft Agenda and Schedule for Next Session of Scoping Meeting
- EPA position paper
  - Use of historical data in planning phase 1 investigation
  - Approach for determining usability of historical data
- Air Dispersion Modeling (pages 133 – 144)
  - EPA suggested agenda for ScopMeetingSess 1A Ambient-Air PRI
  - Letter from State of Utah Department of Natural Resources to US Magnesium on wind monitoring data summary
  - Ambient Air Monitoring near US Mag from 1993 – 1996, 2009 – 2010
- Draft of Scoping Meeting with comments from USEPA and ERM (pages 144 – 175)
- Memorandum for mobile laboratory at US Mag (pages 185 – 189)
  - Proposed for measuring chlorinated dioxins/furans (PCDD/PCDF) and HCB for real time and definitive data
  - Gives methods for measuring PCDD, PCDF, and HCB with QA/QC

- Memorandum for AERMOD simulations air dispersion analysis (pages 190 – 198)
  - ERM proposes use of a steady-state dispersion model to simulate the ambient air effects that occur as a result of emission sources from the facility.
- Correspondence between Ken Wangerud (EPA) and David Abranovic (ERM) about DMA work plan to monitor air (pages 199 – 212)
- Correspondence for Risk Assessment Breakout Calls between EPA and ERM (pages 213 – 220)
- Scoping Meeting- Session 2 for Phase 1 RI (pages 221 – 354)
  - Day 1:
    - Risk Assessment and Breakout Topics
    - Phase 1 Data Quality Objectives (DQO)
      - DQO for PRI 18 (air shed) and PRI 1- 17
    - Triad Sample Design Overview
  - Day 2
    - Demonstration of Applicability (DMA)
    - PRI-specific DQOs and Sample Design
  - Scoping Meeting Agenda – Session 2
  - EPA comments on proposed Phase 1A sampling plan for air
- Preliminary Draft Phase 1A Demonstration of Method Applicability Work Plan for Soil, Sediment, Waste, and Water (July 2012) with appendices (pages 355 – 3971)
  - *Full annotated bibliography will be provided with final version of document*
  - Introduction
  - Demonstration Approach
    - DMA Objective 1: Evaluate implantability of field sampling methods
    - DMA Objective 2: Demonstrate analytical method performance
    - DMA Objective 3: Evaluate the reproducibility of sampling and analyses results
    - DMA Objective 4: Evaluate data management protocols
  - Scope of work
    - Soil, waste, sediment, and water sampling
    - Laboratory analysis
  - Quality control
  - Appendices
- Data Management Plan Draft 2012 (pages 3972 – 4423)
  - Introduction
  - Background
    - Data Management Team
    - Data management System Software Overview
    - Existing Project Database
  - Purpose and Scope
  - Data Types
  - Data Storage
    - General Analytical and Field Collected Data
    - Spatial Data
    - Hard Copy Data
  - Data Management Process
    - Sample Planning
    - Field Data collection
    - Field Data Processing

        - Laboratory-Generated Analytical Data Processing
        - Data Analysis and Reporting
        - Spatial Data Generation and Processing
        - Data Exchange and Administrative Record
    - System Management and Administration
        - Access and Security
        - Data Backup and Documentation Retention
    - Appendix A: Equis Information Sheets
    - Appendix B: Data Type and Format Specifications
    - Appendix C: Laboratory, Scribe, Edge, and Lithology EDD Specifications (on CD)
    - Appendix D: Database Field and Values
    - Appendix F: Site Specific Health and Safety Plan for Phase 1A Investigation (2012)
- Ambient Air PR: Sampling and Analysis Plan Proposal (pages 4423 – 4438)
    - Introduction
        - Risk investigation will address both acute and chronic airborne toxicants that may contribute to inhalation exposures to human and ecological receptors
        - Main elements of SAP:
            - Continuous monitoring for two acute and chronic toxicants: chorine gas, and hydrogen chloride
            - Discrete sampling/analysis for categories of chronic toxicants: VOCs, SVOCs (PAH), HCB, dioxins/furans, PM10
            - Use of dispersion modeling tools, statistical methods, and meteorological data collected concurrently with field samples to quantitatively verify that the sampling locations were properly positioned to capture the actual plume
            - Comparison of the monitored concentrations for chronic analyte classes to accepted industrial RSL for baseline risk assessment
    - Anticipated DMA outcome for acute toxicant monitoring
    - Anticipated DMA outcomes for discrete sampling methods
    - Ambient Air PRI – Development of Phase 1 A Sampling Design
        - AERMOD Dispersion Simulations for Phase 1 A Design
        - Ambient Air Concentration Measurement Methods
        - Selection of Air Monitoring Site
    - Proposed Sampling and Analysis Design for Phase 1A
- Proposal for Phase 1A Sampling and Analysis Plan (pages 4439 – 4517)
    - Phase 1A: Collect ambient air samples to identify COPC from a broad list of potential constituents/analytes
    - Phase 1B: Collect ambient air samples to complete a more thorough characterization of the nature and extent of the ambient air effects
- Draft of Phase 1A Air Quality DMA (pages 4518 – 4563)
    - Demonstration Approach:
        - DMA Objective 1: Evaluate implantability of field sampling methods
        - DMA Objective 2: Demonstrate analytical method performance
        - DMA Objective 3: Demonstrate retrieval and use of on-site meteorological data
    - Scope of Work
        - DMA evaluations for acute toxicant monitoring
        - DMA on-site evaluations for discrete sampling methods
        - Off-site pilot tests for air quality sampling methods

        - Air quality field sampling/monitoring considerations
        - Laboratory analysis
    - Quality Control
- Compendium of Methods for the Determination of Inorganic Compounds in Air (pages 4563 – 4724)
    - Sampling of ambient air for total suspended particulate matter (SPM) and PM10 using High volume sampler
- Compendium of Methods for the Determination of Toxic Organic and Inorganic Compounds in ambient Air First Edition (pages 4725 – 5017)
    - Determination of VOCs in air collected in specially-prepared canister and analyzed by gas chromatography/mass spectrometry
- Memorandum from ERM to Ken Wangerud of the Draft Phase 1A Demonstration of Method Applicability for Soil, Sediment, Waste, and Water (pages 5018 – 5097)
- SOP for Surface Soil and Waste Sampling (pages 5098 - 5129)
- SOP for Surface Water Sampling (pages 5130 - 5140)
- Draft of Air DMA Work Plan (pages 5141 - 5189)
- Draft of DMA for Soil, Sediment, Waste, and Water (pages 5190 – 6826)
- SOP Air Sampling (pages 6827- 6958)
- Compendium of Methods for Toxic Organic Compounds in Ambient Air (pages 6959 – 7016)
- SOP for Air VOCs Using Summa Canisters (pages 7017 – 7029)
- Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air Second Edition (pages 7030 – 7100)
    - Determination of VOCs in air collected in specially-prepared canister and analyzed by gas chromatography/mass spectrometry
- SOP for Ambient Air Sampling for PM10 Using a High-Volume Air Sampler (pages 7101 – 7116)
- Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air (pages 7117 – 7278)
    - Sampling of ambient air for total suspended particulate matter and PM 10 using high volume sampler
- SOP for Continuous Air Monitoring for Chlorine and Hydrochloric Acid Using an Electro-chemical Analyzer (pages 7278 – 7347)
- SOP for Continuous Air Monitoring for Chlorine and Hydrochloric Acid Using a Chemical Cassette Analyzer (pages 7347 – 7440)
- ALS Environmental SOPs (pages 7441 - 8005)
- Draft Data Management Plan 2013 (pages 8012 – 8115)
- Technical Memorandum: Summary of Phase 1A Scoping Discussions (pages 8116 – 8145)
- Scoping Session 2: Air Breakout Session (pages 8146 – 8155)
- Technical Memorandum: EPA-approved Summary of Phase 1A Scoping Discussion (pages 8155 – 8260)
- Draft Human Exposure Survey Work Plan (pages 8261 – 8478)
- Technical memorandum: Draft of Site-wide Ambient Air PRI – Proposal for SAP (pages 8479 – 8537)
- Technical memorandum: Summary of Phase 1A Scoping Discussion (pages 8538-8727)
- Draft of Habit and Wildlife Survey and Mapping Work Plan (pages 8728 – 8871)
    - *Full annotated bibliography will be provided with final version of document*

- Introduction
  - Us Mag operating facility
  - Preliminary remediation investigation areas
  - Overview of the ecosurvey/map work plan organization
- Overview of Existing Information
  - Geology and soils maps
  - Aerial photographs
  - Habitat maps
  - Wildlife-habitat relationships
  - Key information gaps
- Ecosurvey/Map Data Quality Objectives
- Field Survey Design
- Field Survey Methods
  - Habitat survey
    - Modified Relevé Method
  - Wildlife survey
- Mapping Methods
  - Base maps
  - Habitat maps
  - Wildlife-habitat relationships
- Ecosurvey/Map Documentation

- Correspondence for Breakout Meeting Agendas (pages 8876 – 8904)

5. Phase 1A Remedial Investigation Sampling and Analysis Plan for Operable Unit 2- Ambient Air (Revision 1)

Phase 1A_PRIs2&8-17_Air_SAP (1798 pages, 2014)

ERM-Generated Phase 1A remedial investigation sampling and analysis plan (SAP) for ambient air

- Introduction
  - Phase 1A RI SAP PRIs 2 and 8-17 included a description of ambient air at the site, preliminary conceptual site model for the nature and extent of air contamination, and data quality objectives.
    - This is a stand-alone document regarding air related sampling and contamination to fill in placeholders in the 2013 Phase 1A RI SAP.
      - Placeholders remained until the Phase 1A Air DMA was completed
    - Document is comprised of 37 worksheets and 7 appendices as suggested by the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP).
- Worksheet 1- Title and Approval Page
- Worksheet 2- SAP Identifying Information
- Worksheet 3- Distribution List Table
  - Individual roles for risk assessment including contact information and responsibilities.
- Worksheet 4- Project Personnel Sign-Off Sheet
- Worksheet 5- Project Organizational Chart
- Worksheet 6- Communication Pathways Table
- Worksheet 7- Personnel Responsibilities and Qualifications Table
- Worksheet 8- Special Personnel Training Requirements Table
- Worksheet 9- Project Scoping Session Participant Sheet

- Scoping sessions occurred between November 2011 and July 2013 are incorporated in Phase 1A RI SAP.
- Scoping sessions pertinent to OU2 (air) occurred between May 2014 and July 2014.
- Notes from scoping sessions can be found in Appendix B

- Worksheet 10- Problem Definition
  - The preliminary site model on air contamination is provided in the Phase 1A SAP.
  - "Air at the Site may be impacted by releases of gases, aerosols, and/or particulates from the facility stacks, as well as other on-site sources."
  - Potential COPCs in air include: Cl2, HCl, VOCs, SVOCs, PCBs, PCDDs/PCFs, metals, and PM10.
  - "Concentrations are expected to vary as a function of both distance and direction from the Site, and also as a function of time, depending on short-term and long-term (seasonal) variations in meteorological conditions, as well as variations in release rates from plant operations and maintenance activities."
  - Under Administrative Order on Consent (AOC) a baseline Risk Assessment (BRA) will be performed for human and ecological receptors after Screening-Level Risk Assessment (SLRA) is performed on the COPCs.
    - It is expected that Cl_2 and HCl will be evaluated in BRA.
    - The Phase 1A ambient air sampling program will determine if the concentrations of the chronic toxicants are high enough to be included in the BRA.
- Worksheet 11- Project Quality Objectives/Systematic Planning Process Statements:
  - Gives data quality objectives (DQO) and associated sampling strategies and rationale.
  - Objective is to obtain sufficient data to support identification of COPCs for human and ecological receptors.
    - After COPCs are identified, Ecological Risk Assessment (ERA) and Human Health Risk Assessment (HHRA) will be conducted.
  - DQO specify the type, quality, quantity, purpose, and intended use of data:
    - Step 1: State the Problem
      - Air borne contaminants including gases, aerosols, and/ or particulates.
      - Concentrations are expected to vary spatially and temporally.
      - Available data was insufficient to properly characterize air, therefore additional data is needed to characterized COPCs.
    - Step 2: Identify the Goal of the Study
      - Reliably select human and ecological COPCs that require further quantitative evaluation in the risk assessment process.
    - Step 3: Identify Information Inputs
      - Need for adequate and reliable dataset to characterize the range of concentration values that occur in air across time and space.
      - The risk associated with the chronic toxicants is related to long term exposure (i.e. years), therefore an average concentration is needed.
      - Samples are collected over 3-6 days to average out the effect of short-term fluctuations in concentration.
      - Continuous monitoring is done for acute toxicants (Cl_2 and HCL).
    - Step 4: Define the Boundaries of the Study
      - Spatial boundary- radius of 5 miles around the site that will be expanded if data indicates risk to humans or ecological receptors from airborne contaminants is significant at larger distances.
      - Temporal boundaries- refined dispersion modeling using a 3-year data set to select optimum sampling times and locations.

        - Late summer mouths (July-September) had high-biased concentrations at sampling locations within the west to southwest of the Site.
- Step 5: Develop the Analytic Approach
    - A first comparison of time-averaged C_{max} (maximum concentration of a given contaminant) to appropriate RBC.
        - For human receptors, the RBC is the concentration that corresponds to an excess cancer risk of 1 in one million or to a non-carcinogenic hazard quotient (HQ) of 0.1, whichever is lower.
        - For ecological receptors, the RBC is the concentration the corresponds to a HQ of 1.
    - If the C_{max} for a contaminant does not exceed the RBC then it may be excluded as a COPC.
    - If an analyte exceeds the RBC at any location that analyte will be selected as a COPC for the entire site.
- Step 6: Specify Performance of Acceptance Criteria
    - Two types of error can occur:
        - Type 1: a chemical is excluded as a COPC when it should have been retained.
        - Type 2: a chemical is retained as a COPC when it could have been excluded.
    - In order to decrease the likelihood of Type 1 errors, a high number of samples and a reliable method of collection are needed to that any exceedances of the RBC are observed.
    - In this document, USEPA is primarily concerned with selecting chronic toxins.
    - For acute COPCs Cl_2 and HCl have already been selected.
- Step 7: Develop the Plan for Obtaining the Data
    - AERMOD (air dispersion modelling) was used to strategically place monitors in locations and during times when C_{max} was predicted to be exceeded.
        - This is not appropriate for risk assessment (RA), only for identifying the COPCs.
    - In the absence of direct knowledge regarding spatial or temporal variability in air concentrations, 15-20 stations distributed across the Site measuring over extended periods of time would be necessary to characterize C_{max} and would be too costly.
    - Cl_2 and HCl is released in sufficient quantities (tons per day) to be characterized for both acute and chronic exposure.
    - Identification of Optimal Sampling Times and Locations for Chronic Toxicants:
        - Times of maximum impact (high concentrations) can be predicted using AERMOD coupled with site-specific meterological data.
        - AERMOD helps USEPA determine optimum locations for sampling stations.
        - AERMOD:
            - Grid pattern on 250-meter spacing.
            - At each grid average, the relative concentration was calculated for each day for 3 years.
            - The average long-term relative concentration was calculated.
                - Highest long-term average value = modeled average C_{max}.
            - For each grid location, the data was grouped into consecutive 3-day sets to simulate the sampling duration.
            - Data grouped into rolling 3 month sets and grids were ranked on the probability of modeled average C_{max} exceedances.
                - This method identifies locations and times where/when the probability of exceeding the average C_{max} is the highest.
        - Two modelling steps were used with separate sources because the true relative release ratio from each source is not known:

1. Assuming releases are only sourced at stacks (no fugitive emissions) and all releases (Phase 1A Figure 11-2).
2. Assuming all releases come from ground level fugitive emissions (no stack release) (Phase 1A Figure 11-3).
    - If only stack emissions are considered the probability of exceeding the average C_{max} was highest in the summer.
    - If only fugitive emissions are considered the probability of exceeding the average C_{max} was highest in winter.
- USEPA suspects that the stack is the greatest source of air releases at the Site.
    - Based on this assumption and that stack emissions are greatest in summer, they selected summer for sampling. Although this does not capture the maximum fugitive emissions, the probability of exceeding the average C_{max} was 20% for fugitive emissions, so this sampling period is expected to represent both emission sources.
- Based on AERMOD USEPA identified four target sampling stations (Phase 1A Figure 14-15)
    - Some stations were moved after reconnaissance.
    - Station 1 was removed because it was deemed redundant to the nearest station.

- Estimation of the number of samples needed for identification of chronic COPCS:
    - It was determined that 10 samples are needed from each station in order to capture at least one sample that exceeds the modeled average C_{max}.
- Evaluation of data adequacy:
    - The sampling may be considered adequate if the plant is running at typical mode, the wind patterns are sufficient to produce concentration equal to or exceeding the modeled average C_{max}, and if the detection limit for each analyte is sufficient to detect at level of potential concern.
    - In addition to the AERMOD modeling, the concentration of continuously monitored analytes (Cl_2 and HCl) will be used to determine if the plume is contacting the sample location.

- Worksheet 12- Measurement Performance Criteria Table
    - Defines field blank, field spike, laboratory method blank, and laboratory control sample.
- Worksheet 13- Secondary Data Criteria and Limitations Table
    - Can be found in the Phase 1A RI SAP.
- Worksheet 14- Summary of Project Tasks
    - Air sampling was performed at 3 stations for a minimum of 10 back-to-back 3-day air sampling campaigns.
        - Analyzed for SVOCs, PCBs, PCDD/PCDF, VOCs, PM_{10}, and TSP-metals.
        - Meteorological data from ATI station.
        - Each station also has near-continuous monitoring of Cl gas and HCl.
- Worksheet 15- Reference Limits and Evaluation Table
    - Includes target quantitation limits: 1. USEPA risk based screening level (RSL); and 2. laboratory quantitation limits and detection limits for each analyte.
    - A few of the dioxins/furans (including TCDD, the most toxic form of dioxin), heavy metals (arsenic) and VOC analytes had target quantitation limits that were below the laboratory quantitation limit.
    - There was one VOC analyte (1,2-dibromo-3-chloropropane) with a target quantitation limit that fell below the laboratory detection and quantitation limits.
    - An air RSL is not available for chromium.
- Worksheet 16- Project Schedule/Timeline Table

- Worksheet 17- Sampling Design and Rationale
  - Used AERMOD and meteorological data to estimate the probability that a random 30 day sample collected at a grid location (250 meter spacing) within a 30-month time frame would exceed the highest true long-term average concentration anywhere on site.
  - Minimum of 29 discrete air samples must be collected to meet the data quality objectives.
- Worksheet 18- Sampling Locations and Methods/ SOP Requirements table
  - Site 1- optimum location for main stack and near ground fugitive emissions.
  - Site 2- optimum location for main stack.
  - Site 3- optimum location for near ground fugitive emissions.
- Worksheet 19- Analytical SOP Requirements Table
- Worksheet 20- Field Quality Control Sample Summary Table
- Worksheet 21- Project Sampling SOP Reference Table
- Worksheet 22- Field Equipment Calibration, Maintenance, Testing, and Inspection Table
- Worksheet 23- Analytical SOP Reference Table
- Worksheet 24- Analytical Instrument Calibration Table
- Worksheet 25- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
- Worksheet 26- Sample Handling System Table
- Worksheet 27- Sample Custody Requirements
- Worksheet 28- Laboratory QC Samples Table
- Worksheet 29- Project Documents and Records Table
- Worksheet 30- Analytical Services Table
  - Lists method and laboratory for analyzing constituents.
- Worksheet 31- Planned Project Assessments Table
- Worksheet 32- Assessment Findings and Corrective Action Responses
- Worksheet 33- QA Management Reports Table
- Worksheet 34-36 Verification (Step I, IIa, and IIb) Process and Summary Tables
- Worksheet 37- Usability Assessment
- Appendix A- Figures
  - Figure 3- locations of the proposed air sampling stations.
- Appendix B- Project Scoping Documentation
  - Technical Memorandum from ERM to Ken Wangerud (EPA)
    - EPA posed question of whether three sampling stations is sufficient to cover the model-predicted areas.
    - ERM was not satisfied with the analyses of PCBs and dioxins/furans completed by the Burlington ALS Lab and requested to have the analyses done at the Houston ALS Lab.
    - ERM written response for sampling locations.
    - 15 May 2014 PWT3 Technical Scoping Meeting Summary
    - EPA Comments on ERMs Technical Memorandum Proposing Phase 1A Air PRI Sampling and Analysis Plan Changes.
      - EPA will allow ERM to switch labs, but they warn that they do so at their own risk and are responsible for the analyses meeting the data quality objectives.
    - 1 July 2014 PWT3 Technical Scoping Meeting Summary
    - 15 July 2014 ERM Responses to USEPA Comments on Draft Air SAP Worksheets
    - 18 July 2014 USEPA Comments on Phase 1A Air SAP Rev 0 July 2014
    - 23 July 2014 PWT3 Technical Scoping Meeting Summary
- Appendix C- Laboratory Standard Operating Procedures
  - Lists SOPs for laboratory analyses from ALS.
- Appendix D- Field Standard Operating Procedures
  - Lists instruction manuals and calibration information of instruments.

- Appendix E- September 2013 Phase 1A Sampling and Analysis Plan Worksheets 13, 29, and 31-35
- Appendix F- Procedure for Post-Sampling AERMOD calculations
    - Weekly meteorological data from the ATI monitoring station will be analyzed with AERMET (a meteorological processor that works with AERMOD).
    - The ATI data are collected at 2m, 10m, and 50m.
    - If a sample period was predicted by AERMOD to exceed the average C_{max}, then that sample can be used for COPC selection.
    - Appendix also contains a report audit of the ATI monitoring system.
- Appendix G- Sampling and Analysis Plan Modification and Field Modification Request Form

6. Phase 1B Remedial Investigation Sampling and Analysis Plan for Operable Unit 2- Ambient Air- 2016

Phase 1B_RI_SAP_Air.pdf (1525 pages, 2016)

Update on Phase 1A RI SAP for Air because previous continuous monitoring strategy for Cl_2 and HCl were determined to be insufficient. A different instrument was used for continuous monitoring of Cl_2 and HCl at 5 locations around the Site over one year.

- Preface- Outlines the previous documentation for Air on the site
    - Overview of the previously released Phase 1A RI SAP
        - Timeline for important air-related documents given.
        - Air monitoring strategy was discussed.
        - Quality Assurance Project Plans (QAPP) was prepared in 2014.
        - Demonstration of Method Applicability (DMA) was prepared as a precursor to the OU2 Phase 1A Air RI in 2015.
            - Included methods for continuous monitoring of acute target compounds and discrete sampling of chronic target compounds.
        - Results from OU2 Phase 1A Sampling:
            - The objective was "to obtain sufficient data on the concentrations of Site-related contaminants in air to reliably select human and ecological COPCs that require further quantitative evaluation in the risk assessment processes."
            - There was inadequate performance of continuous Cl_2 and HCl monitoring during Stage 2 of the Air DMA.
                - An additional AIR DMA stage was added to test performance and reliability of the new continuous monitoring system: Gastronic True Wireless® electrochemical system.
        - Development of OU2 Phase 1B SAP
            - It is assumed that CL_2 and HCl are acute COPCs on the Site.
            - The objective of the OU2 Phase 1B monitoring is to "obtain continuous and representative ambient air concentration data considering both temporal and spatial factors."
            - Based on air modeling with AERMOD (accepted regulatory dispersion model) 5 continuous monitoring locations were strategically placed on the Site.
            - One year of continuous monitoring began September 2015.
            - Human and ecological risk assessment methods were deferred to the OU2 Risk Assessment Technical Memorandum (pending completion).
- Section A: Project Organization
    - Worksheet 2- SAP Identifying Information
        - Operable Unit 2 (OU2) = PRI 18 = Ambient air within 5-mile radius of the Site

        - The goal of Phase 1B is to collect sufficient data on the concentrations of Cl_2 and HCl in air to support reliable evaluation of human and ecological exposure and risks over time and space.
            - The focus on monitoring methodology is at the acute exposure timescale.
    - Worksheet 3- Distribution List
    - Worksheet 4- Personnel Sign-off Sheet
    - Worksheet 5- Project Organizational Chart
    - Worksheet 6- Communication Pathways Table
    - Worksheet 7- Personnel Responsibility and Qualifications Table
    - Worksheet 8- Special Personnel Training Requirements Table
    - Worksheet 9- Joint Project Planning Session(s) Precipitants Sheet
- Section B: Preliminary Conceptual Site Model and Problem Definition
    - Worksheet 10- Preliminary Conceptual Site model (CSM) and Problem Definition
        - The CSM was given in Phase 1A RI SAP.
        - US Mag Title V Operating Permit issued by UDEQ-AQ allows gas and particulate emission from point source (stacks) and from non-point source (fugitive).
            - For Cl_2, the allowable annual source-wide emission rate is 3,300 tons/year with an additional 7,500 ton/60 months for scheduled maintenance.
            - US Mag reports daily Cl_2 discharge based on mass-balance computations from production rates.
                - Typical release rates are 5-10 tons/day, but the release rates on some days are 10 times greater than the typical value.
        - January 2014 Exposure Incident
            - DNR-GSLEP employees were conducting work on the lake at a “considerable distance” north of the Site and had difficulty breathing as well as severe burning of the throat, eyes, and nasal cavities.
        - Golden Eagle Nesting in Lakeside Mountains
            - Known nest sites located on the Lakeside Mountains occur in areas predicted by AERMOD to have potentially elevated Cl_2 during months when nesting and incubation of eggs occurs.
            - Young eagles could be more sensitive to Cl_2 than adults.
- Section C: Data Quality Objectives
    - Worksheet 11- Data Quality Objectives
        - Step 1: State the Problem
            - Known elevated concentrations of Cl_2 and HCl on Site that can cause adverse effects to humans and environment surrounding the Site.
            - Continuous monitoring will be conducted over a 12-month period.
        - Step 2: Identify the Goal of the Study
            - Goal is to have sufficient data to reliable evaluate exposures to Cl_2 and HCl in ambient air near the US Mag Facility.
        - Step 3: Identify Information Inputs
            - Need to understand short-term and long-term concentrations of Cl_2 and HCl present on Site.
                - Only short-term measurements are collected because long-term averages can be derived from the short-term data.
            - Meteorological data is needed to identify conditions associated with elevated concentrations.
            - Plant operation metrics are needed to understand operating conditions that lead to high concentrations.
        - Step 4: Define the Boundaries of the Study

        - Spatial: 5-mile boundary around the Site.
        - Temporal: instantaneous air concentration readings every minute for 1 year.
    - Step 5: Develop the Analytic Approach
        - Risks from exposure to short term spikes will be characterized by estimating either the duration (minutes per year) or the frequency (events per year) that receptor concentrations exceed appropriate risk-based guidelines.
    - Step 6: Specify Performance or Acceptance Criteria
        - Type I error: Accidently identify exposure as safe when it is not safe.
        - Type II error: Accidently identify exposure as unsafe when it is safe.
            - USEPA is more concerned with Type I errors.
    - Step 7: Develop the Plan for Obtaining the Data
        - Location of sampling stations: Site was divided into 6 equal wedge-shaped sectors radiating outward from the plant.
            - Locations were grouped into geographic zones: Lakeshore, Central, and Upland/Foothill.
            - AERMOD was used to predict the relative likelihood of high concentration (one-hour values that exceed the 95th percentile of the site-wide data set) within each location, both long term (four-year average) and seasonally (by month).
            - One site was selected from the Lakeshore, three sites were selected from the Central, and one site from Upland/Foothill zone.
        - Frequency of sampling was based on human likelihood for exposure at each site.
        - Information on the Gastronics True Wireless® Performance Specifications are given.
        - Figure 11-1 gives the locations for continuous air sampling.
- Section D: Sampling and Analysis
    - Worksheet 12- Measurement Performance Criteria Table
    - Worksheet 13- Secondary Data Criteria and Limitations
    - Worksheet 14- Summary of Project Tasks
        - Project tasks include: air monitoring, QA/QC, secondary data, data management, documentation and records, assessment/audits, data review, and reporting.
            - Results will be published in a Draft Phase 1B Data Report for OU2.
    - Worksheet 15- Reference Limits and Evaluations
    - Worksheet 16- Project Schedule / Timeline
        - First draft of results predicted October 2017.
        - Final Phase 1B RI Data Report for OU2-Ambient Air predicted January 2018.
        - Human Health Risk Assessment developed June 2018.
    - Worksheet 17- Monitoring Program Design and Rationale
    - Worksheet 18- Sampling Locations and Methods/SOP Requirements Table
    - Worksheet 19- Analytical SOP Requirements Table
        - No analytical SOPs given.
    - Worksheet 20- Field Quality Control Sample Summary Table
    - Worksheet 21- Project Monitoring SOP Reference Table
- Section E: Quality Assurance
    - Worksheet 22- Filed Equipment Calibration, Maintenance, Testing, and Inspection Table
    - Worksheet 23- Analytical SOP References
    - Worksheet 24- Analytical Instrument Calibration Table
    - Worksheet 25- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
        - Information for Gastronics True Wireless Monitoring System® under attachment 21.
    - Worksheet 26- Sample Handling System
    - Worksheet 27- Sample Custody Requirements
        - Information on naming samples and download frequency.

- Worksheet 28- Laboratory QU Samples Table
- Worksheet 29- Project Document and Records
- Worksheet 30- Analytical Services Table
- Worksheet 31- Planned Project Assessment Table
- Worksheet 32- Assessment Findings and Corrective Action Responses Table
- Worksheet 33- QA Management Reports Table
- Worksheet 34- Verification Process Table
- Worksheet 35- Data Verification Process Table
- Worksheet 36- Field Data Validation Summary
- Worksheet 37- Usability Assessment
  - Precision and accuracy will be tested with a reference gas because concentrations of Cl_2 and HCl measured on Site may be near the detection limit.
    - A measured Cl_2 or HCl peak greater than "25% of span level (nominally 2.5 ppm) can be used to create a separate data set to provide a secondary method of precision analysis."
  - Data completeness ≥ 80% for a month period will be considered acceptable.
    - "Completeness is a measure of the portion of total available sampling time that the monitors collect and log valid data."

- Attachment 9: Phase 1B RI Scoping Documentation
  - Enclosure 1: Chlorine Releases and Exposures
    - History on the Chlorine Reduction Burner, daily discharge of Cl_2 gas as reported to UDEQ-AQ, and human exposure incidents.
      - The chlorine reduction burner converts Cl_2 to HCl and has a 98% chlorine removal efficiency.
      - Chlorine releases that exceed normal levels occur much more frequently than scheduled maintenance would allow.
      - Human exposure incidents are mainly anecdotal and were reported by people outside the Site.
      - In 2008, 80,000 gallons of Cl were spilled into the waste ditch and workers reported respiratory problems.
      - In 2012, Utah Occupational Safety and Health issued a violation to US Magnesium for multiple incidents.
  - Enclosure 2: OU2 Phase 1B DQO for Cl_2-HCl Investigation
    - This report details how exposure and risk are quantified.
      - Exposure to chlorine was shown to follow the relationship $C^n * d = Constant$, where n = 2, C = exposure concentration, and d = exposure duration.
      - Exposure for HCl follows the same pattern except n = 1.
    - Letter from ERM (Dave Abronovic) to USEPA (Ken Wangerud) stating that the USEPA created the Quality Assurance Plan for chlorine and HCl without consulting ERM.
      - Lists technical concerns ERM has with USEPA's Phase 1B OU2 approach.
        - ERM argued that the monitoring locations selected by USEPA were arbitrary and should be based on dispersion modeling as was done for the Phase 1A OU2 RI.
        - ERM argued that because chlorine does not persist in the atmosphere the USEPAs risk assessment for chronic exposure was invalid.
      - Response letter from USEPA to ERM
        - USEPA asserted that the air modeling from Phase 1A was not designed to evaluate Cl_2 and HCl and these results should not be used to determine the need to investigate Cl_2 and HCl.
      - Memorandum from USEPA to ERM detailing draft Phase 1B OU2 field program as an alternative to the previously sent Quality Assurance Project Plan (QAPP).

- Appendix A: Definition of Acute Exposure Guideline Levels (AEGL) and Toxicological References.
  - AEGL1 (mild) was determined to be 0.5 ppm from studies testing healthy and atopic (sensitive or asthmatic) individuals. No adverse effects were observed below this level.
  - AGEL2 (moderate) was determined to be 2 ppm from clinical studies involving healthy and sensitive adults. Subjects were exposed to a maximum of 4 ppm for 4 hours and experienced transient pulmonary changes and sensory irritation.
  - AEGL3 (severe) was determined to be 20 ppm from animal studies (rats). The rats were subjected to up to 300 ppm for 1 hour and lethal doses were reached. Uncertainty factors were applied to apply the limit to humans.
- Appendix B: CALPUFF Supporting Information and Wind Roses
  - CALPUFF is an air quality model
- Appendix C: Vendor Information for Two Candidate Continuous Monitoring Systems
- March 10, 2015 Scoping Meeting Agenda and Notes
- Email from Ken Wangerud to Dave Abronovic dated March 23, 2015 regarding Phase 1B OU2 timeline.
  - USEPA does not recommend using CALPUFF to determine monitoring locations.
  - CALPUFF is better suited for predicting exposure at distances > 50 km from the source and AERMOD is better suited for distances < 50 km.
  - ERM proposed using CALPUFF to predict 10-minute interval wind patterns to fit short term exposure guidelines, however the CALPUFF model has not been configured for sub hourly outputs.
- Response email from Dave Abronovic to Ken Wangerud dated April 14, 2015
  - ERM agreed to use the AERMOD model with 1-hour average concentrations to determine monitoring locations.
- Response email from Ken Wangerud to Dave Abronovic dated April 27, 2015
  - It is not required that the USEPA reach an agreement with ERM on points of disagreement.
  - USEPA agreed to defer several issues from the SAP, including exposure frequency goals and exposure mean concentration values for Cl_2 and HCl.
- Memorandum from USEPA detailing Phase 1B OU2 Site monitoring locations
  - AERMOD was used to model the likelihood of acute exposure to select candidate monitoring locations.
  - 12 candidate sampling locations were selected with 5 nodes in each location.
  - The frequency of modeled events is based off of the number of consecutive hours that a predicted concentration will exceed the 95^{th} percentile threshold.
  - The top-ranked (highest frequency of events) stations for stack emissions are generally not close to the plant.
  - The top-ranked stations for fugitive emissions are close to the plant.
  - Station 2 was the highest ranked stack emitter among the stations close to the plant during the summer months.
  - Station 1 was the highest ranked fugitive emitter among the stations close to the plant during the winter months.
    - Question from TAG: Document indicates that Station 2 was eliminated based on redundancy with Station 1. Yet the bullet point above suggest that these stations represent different emission sources.
  - Station 9 was high ranking year-round.
  - Station 11 near the lakeshore is the best suited for monitoring exposure to shrimp harvesters who work in the winter.

        - Station 7 to the south captures exposure to ranchers, recreators, and land managers who work in the summer.
    - Email from Ken Wangerud to Dave Abronovic dated September 17, 2015
        - USEPA stated that all of the selected monitoring stations should be monitored year-round.
- Attachment 10: Golden Eagle Nest Survey Maps
- Attachment 14a: SAP Modification Form
- Attachment 14b: Field Modification Form
- Attachment 21: Field Standard Operating Procedures
- Attachment 29: Data Management Plan

Phase 1AB

1. Phase 1AB RI SAP

Phase 1AB_PRIs1&3-7_RI_SAP (1130 pages, 2015)

- Objectives:
    - Determine Chemicals of Potential Concern (COPCs) in soil, sediment, and solid waste in PRI Areas 1 and 3 through 7
    - Preliminary Site Characterization Mapping of PRI Areas 1 and 3 through 7
    - Background Chemical Assessment of Biotic Reference Areas for Sitewide Ecological Risk Assessment.
- Preface:
    - Site background
    - Administrative Settlement Order on Consent for RI/FS
    - Phase 1 A RI SAP
    - Development of Phase 1 A-B RI SAP
    - State and Federal Consultation
- Section A: Project Organization
    - Worksheet 2: SAP Identifying Information.
    - Worksheet 3: Distribution List Worksheet
    - Worksheet 4: Personnel Sign-off Sheet
    - Worksheet 5: Project Organizational Chart
    - Worksheet 6: Communication Pathways Table
    - Worksheet 7: Personnel Responsibilities and Qualifications Table
    - Worksheet 8: Special Personnel Training Requirements Table
    - Worksheet 9: Joint Project Planning Session(s) and Participants Sheets
- Section B: Preliminary Conceptual Site Model and Problem Definition
    - Worksheet 10: Background Study
        - Background levels must be characterized to differentiate which COPCs are site-related and which are naturally occurring.
        - Metals and organics (HCB, Dioxins/furans, and PCB) will be measured.
- Section C: Data Quality Objectives
    - Worksheet 11: Project Quality Objectives/Systematic Planning Process Statements
        - Objectives of the Phase 1A-B RI
        - Data Quality Objectives for COPC Selection and Preliminary N&E at Inner PRI Areas

- Rationale for new samples is that historic measurements are not sufficient for COPC selection and may not reflect current near-surface conditions. Also, historic measurements were not collected with an unbiased sampling distribution.
- Vertical profiles need to be measured within waste release locations including the Wastewater Ditches, the south-central portion of the Gypsum Pile (where the pile is tallest), the Southeast Ponded Waste Lagoon (near the outlet of the Main Ditch), the historical inlet to the northeast ponded Waste Lagoon, and the former wastewater diversion ditch traversing the Southeast Ponded Waste lagoon.
- Sampling is to occur once per year as COPC concentrations are not expected to vary seasonally. For the safety of the workers, sampling is not to be performed during spring due to high runoff, or during the heat of summer.
    - Potential concern that the two periods (high runoff and heat) may represent periods of maximum contaminant mobility.
- COPCs are selected by comparing the maximum measured concentrations (Cmax) to risk-based concentrations (RBC). If the Cmax is less than RBC, then the chemical is not considered a COPC. The minimum sample size for each PRI is 14 in order for 95% of the samples to fall above the true mean. In addition to these unbiased samples, additional "biased" or targeted samples will be taken.
- All samples in PRI 1 (ditches) were judgmentally selected (biased) because the ditches are linear features. Instead, 1 sample every 700 ft was selected to ensure even sampling of all of the ditches occurred.
- Surface samples will be taken 0 – 6 in below ground surface. Subsurface samples will be hand augured up to 5 ft deep.
- It is possible that contaminant concentrations in the soil may increase with depth. This is possible if past plant operations released higher concentrations or if historic waste has been buried beneath inert material.
- All samples will be tested for the following COPCs: PCBs, Dioxins/furans, SVOCs including HCB, PAHs, VOCs, metals, cyanide, and perchlorate. In addition, TOC, pH, and grain size will be characterized for subsequent risk assessments.
- Bulk (material < 0.25 in) and fine (material <0.25 mm) measurements will be conducted to determine (1) if constituent concentrations significantly differ between bulk and fine fractions, and (2) whether a large-enough proportion of coarse material is present in bulk samples to result in a substantial difference between the constituent concentrations measured in the bulk and the fine fractions (this is true if more than 75% of the sample is fine).

▪ Data Quality Objectives for Background Evaluations
- The purposes of the background study are:
    - Characterize background concentrations to identify site-related metals and organics (D/Fs, total PCBs, and HCB).
    - Identify background soil/sediment reference locations to use in Phase 2 to characterize tissue burdens.
- PAHs will not be characterized because only 1 PRI (the landfill) had concentrations exceeding the RBC based on Phase1A measurements and are not considered a significant risk.
- Historic datasets provide background concentrations of metals in the native soil, however none of them are sufficient for risk analysis.

- The spatial boundaries of the background study are outside the 5-mile site boundary and circumscribe similar lithologies and foraging habitats as the site. Two background settings will be characterized, the Lakebed and Upland settings. A sample size of 30 for metals and 18 for organics will be used for each.
- Site lithologies include:
  - Surficial Quaternary Lake Bonneville deposits (Ql)
  - Surficial Quaternary mud and salt flat deposits associated with the lake bed of the GSL (Q2)
  - Quaternary alluvium and colluvium (Qs)
  - Consolidated rock in the Lakeside Mountains (C1, C2, C3, D, O, and S)
- Site soils include:
  - Playas-Saltair – associated with the Lakebed of the GSL
  - Amtoft-Rock
  - Dynal – Oolitic sand deposits
  - Skumpah
  - Yenrab
  - Other
- The Lakebed setting includes the Quaternary alluvium and colluvium geologic type (Qs), and is comprised of the Playas-Saltair soil type, and falls primarily into PRI Areas 13 and 14.
- The Upland setting includes the Surficial Quaternary Lake Bonneville deposits (Ql) and "Other" geologic types, and are comprised of the Dynal, Skumpah, Yenrab and other soil types. They fall under PRI Areas 11, 12, 15, and 16.
- Criteria for selection of Background Sampling Areas for Upland habitat include:

▪ Located beyond the 5-mile radius of the Site and at least 500 feet from the edge of the 5-mile radius to ensure the horned lark is not foraging within the RI/FS Site boundary;
▪ Contains minimally disturbed IMB greasewood flat or annual invasive grassland land cover;
▪ Collection of bird eggs (likely horned lark), small mammals, plants, and invertebrates is very likely; and
▪ The location was accessible for sampling.
▪ Criteria for selection of Background Sampling Areas for Lakebed habitat include:
  - Located beyond the 5-mile radius of the Site and at least 1,000 feet from the edge of the 5-mile radius to ensure the snowy plover and American avocet are not foraging within the RI/FS Site boundary;
  - Contains minimally disturbed IMB playa land cover;
  - Collection of bird eggs (likely snowy plover and/or American avocet), plants, and invertebrates is very likely; and
  - Location was accessible for sampling.
▪ The Upland background dataset will be compared to PRI Areas 1 through 6, 8 through 12, and 15 and 16, while the Lakebed background dataset will be compared to PRI Areas 7, 13, and most of 14.
▪ A contingency background study will be conducted during Phase 2 at the Bear River Migratory Bird Refuge in the event that biological data cannot be collected from the Upland and Lakebed areas. Five contingency samples were collected and will be used only in the case that the Upland or Lakebed samples are affected by Site activities.

        - Comparison analyses (hypothesis tests and Q-Q plots) between the Site and the background concentrations will be conducted. In addition, a geochemical analysis will be conducted for metals and signature fingerprinting will be conducted for organics.
        - Hypothesis tests (WRS/Gehan and quantile tests). WRS/Gehan compares the central tendency of data distributions and quantile tests compare the tails.
        - Q-Q plot evaluation will be used to identify inflection points that may indicate changes in geologic units or a threshold between background and Site-related concentrations.
        - Geochemical analysis is conducted by comparing elemental ratios of abundant versus trace-metals (for example iron and arsenic). Samples are considered elevated when they fall above the 95% confidence interval of natural linear relationships.
        - Signature fingerprinting was conducted for dioxin/furans and co-planar PCB congeners and PCB homologs. Congeners in each class of contaminants will be compared to background proportions.
        - Subsurface sampling will also be conducted to ensure the absence of subsurface contamination in the reference locations.
- Section D: Sampling and Analysis
    - Worksheet 12: Measurement Performance Criteria
        - Includes QC Sample, Analytical Group, Minimum Frequency, Data Quality Indicators (DQI), Measurement Performance Criteria, QC Sample Assesses Error for Sampling.
    - Worksheet 13: Secondary Data Criteria and Limitations
        - Provides the historic data used in Phase 1AB to determine the nature and extent of contamination and potentially for background dataset evaluations. This SAP worksheet covers data source, type, how it will be/was used, and the limitations on data use.
    - Worksheet 14: Summary of Project Task
        - Includes a brief description of each project task.
            - Phase 1A-B project objectives are:
        - Reliable identification of COPCs for human and ecological receptors within PRI Areas 1 and 3 through 7.
        - Initial risk calculations to evaluate whether sufficient data have been collected within PRI Areas 1 and 3 through 7 to support confident risk characterization.
        - Preliminary evaluation of the N&E of Site-related impacts within PRI Areas 1 and 3 through 7.
        - Estimation of background (ambient) concentrations for metals and organics including D/Fs, total PCBs and WHO congeners, and HCB.
        - Identification of suitable reference areas (i.e., non-impacted areas) for biota sampling that may be conducted during 2016 Phase 2 RI activities.
    - Worksheet 15: Reference Limits and Evaluation
        - Identifies methods and detection limits to ensure methods are sensitive enough to detect each analyte at concentrations of potential concern.
        - The Target Quantitation Limit (TQL) is set to the Risk Based Concentration (RBC). For carcinogens, the RBC is set equal to a 1E-6 risk level. For non-carcinogenic contaminants, the RBC is equal to a hazard quotient (HQ) of 0.1. For ecological receptors, the RBC is set equal to a HQ of 1.0. For dioxins/furans and PCB congeners, the TQL is based on the toxic equivalency (TEQ).
    - Worksheet 16: Project Schedule/Timeline
        - Table outline Phase 1A-B timeline.
    - Worksheet 17: Sampling Design and Rationale
        - Describes the technical approach used to develop the sample designs for the Phase 1A-B RI.

        - Provides Quality Control Measures for Phase 1A-B Sample Designs.
        - Describes collection of duplicate samples (1 for every 10 samples collected) and equipment blanks.
    - Worksheet 18: Sampling Locations and Methods/SOP Requirements Table
        - Includes sample area location, UTM coordinates, sample type (surface or subsurface), location basis, rational for biased or subsurface locations, and analytical group.
    - Worksheet 19: Analytical SOP Requirements Table
        - Includes sample matrix, analytical group, analytical preparation methods/SOP reference, containers, sample preparation/analysis volume, preservation requirements, and maximum holding time.
    - Worksheet 20: Field Quality Control Sample Summary Table
        - Includes sample matrix, analytical group, no. of samples collected, no. of field duplicates, no. of MXS/MSDs, no. of equipment blanks, approximate/estimated total number of samples.
    - Worksheet 21: Project Sampling SOP Reference Table
        - Lists of all relevant ERM SOPs found in Attachment 21.
- Section E: Quality Assurance
    - Worksheet 22: Field Equipment, Calibration, Maintenance, Testing, and Inspection Table
    - Worksheet 23: Analytical SOP References
    - Worksheet 24: Analytical Instrument Calibration Table
    - Worksheet 25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table: Details equipment used for each COPC measurement
    - Worksheet 26: Sample Handling System
    - Worksheet 27: Sample Custody Requirements
        - Field Sample Custody Procedures
        - Sample Identification Procedures
        - Laboratory Sample Custody Procedures
    - Worksheet 28: Laboratory QC Sample Table: Details quality control measures taken for each analyte
        - Project Documents and Records
    - Worksheet 29: Project Documents and Records
        - Storage of Project-related Documents
        - Requirements for Laboratory Data Packages
        - GIS Data Delivery Requirements
    - Worksheet 30: Analytical Services Table: Details labs responsible for each analysis
        - All analyses were done by Test American except for LRMS & PCB analysis performed by Alpha Analytical and grain size analysis performed by GeoStrata.
    - Worksheet 31: Planned Project Assessments Table
    - Worksheet 32: Assessment findings and Corrective Action Responses Table
    - Worksheet 33: QA Management Reports Table
    - Worksheet 34: Verification (Step I) Process Table
    - Worksheet 35: Validation (Steps IIa and IIb) Process Table
    - Worksheet 36: Analytical Data Validation (Steps IIa and IIb) Summary
        - Field Data Verification
        - Laboratory Data Verification
        - Laboratory Data Validation
        - Cursory Data Validation
        - Full Data Validation

        - Data Validation Criteria
    - Worksheet 37: Usability Assessment
        - Measurement Quality Objectives for COPC Selection
            - Precision:
                - Measured with an RPD calculation for sample duplicates.
            - Accuracy:
                - Percent recovery will be measured with sample spikes including MXS samples (inorganic analyses only), LCS or blank spikes, and method blanks.
            - Representativeness
            - Completeness
            - Comparability
            - Sensitivity
                - Quantitation limit (QL) is usually several times higher than minimum detection limit (MDL) to allow for matrix effects.
        - Data Quality Assessment Approach
        - Data Adequacy for COPC Selection
        - Background Data Usability Assessments
        - Evaluation of Metals in Background Datasets
        - Evaluation of Organics in Background Datasets
        - Confirmation of Background Sample Size Adequacy
- Attachments
    - Attachment 2: Site management and project plan
    - Attachment 9: Phase 1 A-B RI Scoping Documentation (9A to 9OO)
        - Includes many attachments relating to meeting agendas, drafts, etc.
    - Attachment 10: Historical Aerial Photographs
    - Attachment 11: Background/reference area identification technical memorandum
    - Attachment 14A: SAP Modification Form
    - Attachment 14B: Field Modification Form
    - Attachment 15: Reference Limits and Evaluation Table
    - Attachment 19: Laboratory Standard Operating Procedures
    - Attachment 21: Field Standard Operating Procedures
    - Attachment 29A: Data Management Plan
    - Attachment 29B: U.S. EPA Region 8 GIS Deliverable Guidance
    - Attachment 30: Laboratory Qualifications and Certifications

2. Phase 1AB Data Report

Phase 1AB_PRIs1&3-7_RI_Data Report (1316 pages, 2016)

- Introduction
    - Phase 1A-B RI Remedial Investigation Objectives
        - Information in this section is repeated in the Phase 1A-B RI SAP.
        - Phase 1A-B covers the Inner PRI areas 1 and 3 through 7.
        - Objectives include:
            - Reliable identification of COPCs for human and ecological receptors.
            - Determination of whether data is sufficient for risk calculation.
            - Preliminary evaluation of nature and extent of site-related impacts.
            - Estimation of background (ambient) concentrations.

        - Identification of suitable reference areas.
    - Phase 1A-B RI Sampling and Analysis Plan and Field Modifications.
        - Reviews minor changes in plan, such as moving a sample target location a short distance.
        - These changes are listed in Appendix A Report Organization.
- Pre-Phase 1A-B RI Reconnaissance Activities
    - Cultural Resources Survey
        - Required under Title 46, Section 800 of the Code of Federal Regulations.
        - A professional archaeologist from Logan Simpson Design, Inc., conducted a literature survey and Class III inventory.
        - 100-square meter areas were surveyed in the Upland South and Upland North background areas.
        - The survey concluded that no cultural material was present.
    - Sample Location Reconnaissance
        - The former Boron ditch was located using ground penetrating radar.
- Phase 1A-B RI Field Investigation Activities
    - Inner PRI Area Sampling
        - Surface samples were collected using a hand auger or Ponar sampler from excavator bucket.
        - Subsurface samples were collected using a sonic drill rig.
            - Boreholes were sampled until contact with native soil.
        - PRI 1 (Ditches):
            - 14 surface solids samples were collected.
            - 5 subsurface solids samples were collected.
        - PRI 3 (Sanitary Lagoon):
            - 14 surface solids samples were collected.
            - 2 subsurface solids samples were collected.
        - PRI 4 (Gypsum Pile):
            - 14 surface solids samples were collected.
            - 4 subsurface solids samples were collected.
        - PRI 5 (South End of Active Waste Pond):
            - Covers 330 acres.
            - Greatest depth approximately 2 m.
            - A former diversion ditch connects the south end to the north end.
            - 20 surface solids samples were collected.
            - 2 subsurface solids samples were collected.
        - PRI 6 (North End of Active Waste Pond)
            - Covers 174 acres.
            - Greatest depth approximately 1.5 m.
            - Receives wastewater from PRI 5 and runoff from the Gypsum Pile.
            - 15 surface solids samples were collected.
            - 1 subsurface solids sample was collected.
            - 1 sample was co-located on the Gypsum Pile (Samples 6-16 and 4-11).
        - PRI 7 (Old Waste Pond)
            - Covers ~800 acres.
            - Greatest depth approximately 1 m near historic inlet.
            - 17 surface solids samples were collected.
            - 1 subsurface solids sample was collected.

        - A zone of green silt was present at a depth of 8.5-9.5 ft bgs. The color indicated that it was from lake deposits that predate US Mag operations, therefore it was not analyzed.
    - Quality Control:
        - 10 field duplicates were collected.
        - 8 equipment blank samples were collected.
    - Background Areas Sampling
        - 65 surface solids samples were collected with 8 field duplicates.
        - 1 subsurface solids sample was collected from each background area (7 total).
        - No trip blanks were collected (VOCs were not measured).
- Phase 1A-B RI Sample Analysis and Data Management
    - Laboratory Analyses
        - Target analytes include: PCBs, dioxins/furans, SVOCs, PAHs, VOCs, metals, cyanide, perchlorate, TOC, pH, and grain size.
        - Background sample analytes include: metals, PCBs, dioxins/furans, HCB, and TOC.
        - Most analyses performed by TestAmerica.
            - "A key component of the work instruction is the identification of samples as either "high level" or "low level" based on their location or the presence of waste. Sample preparation and/ or analytical procedures differed for high-level versus low-level samples."
            - "Two samples with less than 75 percent fines could not be sieved at TestAmerica due to the nature of the matrix (7-10-SS- 01-092815 and 7-17-SS-01-092915). The samples appeared oily and formed balls of soil that would not pass through the sieve. Consequently, the fine fraction was not analyzed in these samples."
    - Data Validation
        - Stage 2B data validation conducted on 90% of samples
        - Stage 4 data validation conducted on 10% of samples.
    - Data Management
        - Toxic equivalency (TEQ) was calculated for dioxins and dioxin-like compounds.
        - Total PCBs was calculated for all PCB homologues.
- Phase 1A-B RI Investigation Results
    - Inner PRI Area Surface and Subsurface Solids
        - Presented in analytical tables, prevalence tables (statistical summaries), and point concentration maps.
    - Fines Analysis of Inner PRI Area Surface Solids
        - "Bulk fraction" was defined as "all material passing a 0.25-inch mesh sieve" and "fine fraction" was defined as "material passing a 0.25-millimeter (60 US Mesh) sieve."
        - 36% of the Inner PRI surface solids sample locations had material comprised of < 75% fines, and required separate analyses for the bulk versus fine fractions.
    - Background Area Surface and Subsurface Solids
        - Results are presented in analytical and prevalence tables.
- Quality Control Activities
    - Field and Laboratory QC Sample Results
        - Field requirements are listed in SAP worksheets 12 and 20.
        - Lab requirements are listed in SAP worksheets 12 and 28.
    - Project Assessments and Corrective Actions
        - Field surveillance was performed by an ERM field team leader.
        - Laboratory surveillance at TestAmerica facility was conducted by an ERM quality assurance manager.

        - One corrective action report was issued to Alpha Analytical for an error in calculating Total PCBs when there were multiple analytical runs at different dilutions for the same sample. The laboratory corrected the calculations and re-issued the analytical reports.
- Preliminary Nature and Extent Mapping at Inner PRI Areas
    - To date the nature and extent of site-related impacts in Inner PRIs has not been characterized.
        - Historical data on site did not include analyses for all current target analytes and there was either an insufficient number of samples collected, or the sampling locations were not suitable (biased).
    - Development of Nature and Extent Mapping Data Set
        - Three maps showing the nature and extent of contamination were generated:
- Current measurements (2012 and 2015).
- Historical measurements.
- Combined current and historical measurements.
        - Historical data was compared qualitatively to current data and was generally considered acceptable if historical values were within a factor of five of current values.
            - 35 historical samples were rejected in PRI 1 (mostly in the Western Ditch).
            - 25 historical samples were rejected in PRI 4.
            - 21 historical samples were rejected in PRI 6.
            - 16 historical samples were rejected in PRI 7.
        - Accepted historical data combined with current data was used for statistical evaluations, and nature and extent mapping that will be used in future risk assessment and remediation plans.
    - Preliminary Nature and Extent Mapping
        - Maps generated using GIS with Inverse Distance Weighting and Kriging methods.
    - Statistical Evaluations
        - Includes descriptive statistics, box plots, quantile-quantile (Q-Q) plots, and scatter plots.
            - The variability in concentrations, as expressed by the coefficient of variation, is highest for mammal TEQ in PRI Areas 6 and 7 and is highest for HCB and Total PCBs in PRI Areas 3 and 5.
            - Variability was lowest in PRI Area 4 for all expected risk drivers.
            - Most sample sets (12 out of 18) were characterized by lognormal distributions, with the remainder of the sample sets indicating no discernable distribution.
            - For PRI 5 and PRI 6 (Active Waste Pond) the inundated versus not-inundated samples appear to fall under to separate risk populations (distinct concentration populations).
            - The following analytes/PRIs may also have multiple populations present based on breaks in the Q-Q plots:
                - PRI Area 1 - HCB, mammal TEQ, and Total PCB
                - PRI Area 3 - Mammal TEQ
                - PRI Area 7 - Total PCBs
            - The scatter plots suggest risk driver concentrations increase with elevation in PRI Area 7 (Old Waste Pond), and decrease with elevation in PRI Area 4 (Gypsum Pile).
    - Vertical Nature and Extent
        - Waste thickness at each sample location was measured.
            - Reported waste thickness of 60 inches may reflect a minimum, since the hand auger excavates to maximum 60 inches depth.
        - Subsurface concentrations may be greater than surface concentrations when:
            - Historic waste material (chemical type/concentration) changed over time.
            - Historic waste may have been covered by clean or less-impacted material.

        - Chemical transport may be different for surface relative to subsurface.
    - Figures
        - Figure 1-1 through 3-12 show maps of sampling locations for PRIs and reference areas.
        - Figures 5-1 through 5-6 show concentrations of HCB, total PCB, and Mammal TEQ (dioxin/furans) for Inner PRIs.
        - Figures 7-1 through 7-36 show historical and current results for HCB, PCB, and Mammal TEQ for Inner PRIs. Results from inverse distance weighed and empirical Bayesian kriging, with associated uncertainties are also shown.
        - Figures 7-37 through 7-39 show boxplots for current and historical measurements of HCB, PCB, and Mammal TEQ by Inner PRI.
        - Figures 7-40 through 7-57 show QQ plots for HCB, PCB, and Mammal TEQ for each Inner PRI.
        - Figures 7-58 through 7-59 show concentrations of HCB, PCB, and Mammal TEQ as a function of elevation.
        - Figures 7-60 through 7-62 show concentrations of HCP, PCB, and Mammal TEQ as a function of depth.
    - Tables
        - Provide raw data used in generating figures.
- Appendix A USEPA-Approved SAP Modifications
- Appendix B USEPA-Approved Field Modifications
- Appendix C Field Documentation
    - C-1 Surface Solids Sampling Forms
    - C-2 Field Borehole Logs
    - C-3 Field Logbooks
- Appendix D Borehole Logs
- Appendix E Laboratory Reports (on DVD)
- Appendix F Data Validation Reports (on CD)
- Appendix G Evaluation of Bulk versus Fines Fraction Soil Analysis for Inner PRI Areas
    - Exposure may be underestimated if fines concentrations exceed bulk concentrations.
    - Concentrations associated with fines were plotted against bulk concentrations for each analyte. If the data did not fall on a 1:1 slope, a correction for bulk concentration factor was calculated (i.e. C_{fine}=correction*C_{bulk}).
    - Most analytes required no correction because the fines vs. bulk concentration slopes were approximately equal to 1.
        - Since bulk concentrations include fines, the y-intercept exceeds zero.
        - PCB and copper were exceptions having greater concentrations associated with fines. Correction factors for bulk concentrations were determined for these analytes.
    - Attachment A Boxplots of the Bulk and Fine Fraction for each PRI
        - Mercury concentrations were 5 mg/kg in PRI 3 (ditches).
    - Attachment B Fine Fraction vs. Bulk Sample Scatterplots
- Appendix H Data Usability Assessment for Inner PRI Area Samples
- Appendix I Data Usability Assessment for Background/Reference Samples
        - Background samples from Lake Bed have a similar TEQ and PCB fingerprint to the site.
            - Sites were not used for TEQ and PCB, but for HCB and metals
- Appendix J Agency Approval Letter