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Por e-mail
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Ref.: Respuestas de Chiquita Canyon, LLC a los Comentarios del DTSC sobre el Plan de Trabajo Preliminar para la Acción de Remoción: Proteger a la Celda 8A de Intrusión de Evento de Vertedero de Temperatura Elevada - Determinación de Peligro Inminente y Sustancial y Orden del DTSC sobre el Asunto del Vertedero de Chiquita Canyon, Expediente No. HSA-FY24/25-082

Estimada Sra. Barclay:

Chiquita Canyon, LLC (Chiquita) presenta esta respuesta a la solicitud enviada por e-mail el 15 de octubre de 2025 por el Departamento de Control de Sustancias Tóxicas (DTSC) que proporciona comentarios sobre el Plan de Trabajo de Acción de Remoción (RAW) para Proteger la Celda 8A de Intrusión de Evento de Vertedero de Temperatura Elevada, presentado el 1 de julio de 2025 conforme a la sección 5.3 sobre la Determinación de Peligro Inminente y Sustancial y Orden del DTSC emitida a Chiquita el 2 de abril de 2025 (la Orden).

El RAW preliminar detallaba la intención de Chiquita de proteger la Celda 8A a través de sus esfuerzos continuos por facilitar la remoción de calor de la masa de desechos mediante la extracción tanto de gases como de líquidos junto con la barrera de suelo existente. El RAW preliminar también explicaba que si el Comité de la Reacción determinaba que había un empeoramiento importante de la reacción hacia el sur, pasando el límite de reacción de la Condición 9(a), Chiquita además respondería con las acciones descritas en el Plan de Quiebre/Barrera de Suelo de la Reacción, que podría incluir la construcción de otros pozos de extracción de líquidos y de biogás, instalación de bombas y una mayor utilización de sistemas de oxidación para manejar las emisiones.

El DTSC proporcionó comentarios sobre el RAW preliminar de Chiquita más de tres meses más tarde, el 15 de octubre de 2025. La carta del DTSC también incluyó comentarios de CalRecycle con fecha 12 de septiembre de 2025. El DTSC solicitó que Chiquita responda a estos comentarios en una carta e indicó si Chiquita pretende buscar la opción de las "alternativas" descritas en el Comentario General No. 5 de las páginas 5 a 6 de los comentarios del DTSC.

Chiquita continúa sosteniendo su posición de que la barrera vertical solicitada no es segura, es técnicamente inviable y perjudicaría la eficacia de las medidas de mitigación existentes de Chiquita. Por tal motivo, Chiquita continúa rechazando respetuosamente la instalación de la barrera vertical solicitada y en cambio elige explícitamente buscar la opción de las "alternativas".[1] Chiquita se encuentra en el proceso de evaluar alternativas viables que aseguren el éxito continuo de las medidas de mitigación que ya están puestas en práctica para manejar la reacción mientras trata la solicitud del DTSC de proponer alternativas que protejan la Celda 8A. Las alternativas propuestas además incluirán la combinación de parámetros y puntos de datos que activen la implementación, como también los plazos aproximados para la implementación. Las alternativas seleccionadas dependerán de las condiciones reales del Vertedero y están sujetas a cambios. Chiquita presentará tanto el Plan de Trabajo Alternativo para la Protección de la Celda 8A como un Plan de Trabajo para la Estabilidad de la Pendiente y una versión abreviada de un RAW preliminar revisado. Todas las presentaciones cumplirán con el estándar de práctica de los planos de ingeniería preliminares y con los informes a ser presentados al Estado de California, porque ya es una práctica para Chiquita.

El perito de la estabilidad de la pendiente de Chiquita se encuentra en el proceso de evaluar aún más la estabilidad de la pendiente de Chiquita y actualizará el modelado y los análisis sobre la estabilidad de la pendiente de Chiquita globalmente, que incluirán actualizar sus análisis de la pendiente oeste y norte previos e indicará los criterios utilizados para este modelado y análisis y explicará la estabilidad sísmica. Chiquita anticipa proporcionar al DTSC el Plan de Trabajo de la Estabilidad de la Pendiente para este análisis el 17 de diciembre de 2025 en virtud de los próximos feriados y la obra sustancial que debe completarse de forma diligente para completar esta tarea.[2] Los peritos de Chiquita han elaborado análisis de estabilidad de la pendiente para Chiquita en varias ocasiones. Más recientemente, como ya sabe el DTSC, un perito de Chiquita completó un análisis y evaluación de la estabilidad de la pendiente para el Parque de Tanques 13 en la Celda 8B y descubrió que la construcción del parque de tanques llega a factores estáticos globales aceptables y se considera estable tanto estática como sísmicamente.[3] Un perito de Chiquita también proporcionó previamente modelados y análisis estáticos y sísmicos para los parques de tanques el 27 de noviembre de 2024 y llegó a la conclusión de que el Cañón B, que estaba siendo considerado para la reubicación del Parque de Tanques 9 en ese momento, era una ubicación estáticamente estable para el parque de tanques.[4] Además, otro perito previamente proporcionó modelados y análisis sobre la estabilidad de la pendiente para la base de la pendiente del Cañón Principal y otras pendientes de inquietud en varias ocasiones,

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[1] Chiquita refuta la declaración del DTSC de que Chiquita hizo caso omiso a la necesidad de la barrera que estaba "fuera de control". Chiquita pasó mucho tiempo el último año evaluando la viabilidad y la protección de la barrera vertical solicitada. Chiquita primero comunicó sus inquietudes sobre la inviabilidad de la barrera el 26 de noviembre de 2024 cuando Chiquita presentó primero el Plan de Quiebre/Barrera de Suelo de la Reacción a la Agencia de Protección Ambiental de Estados Unidos. Previo a esta presentación, Chiquita, junto a sus consultores, buscaron múltiples líneas de análisis y resolución de problemas para intentar desarrollar un plan para la instalación de la barrera vertical solicitada que fuera tanto viable como segura. Chiquita y sus consultores no pudieron identificar una solución efectiva. Sin embargo, para poder responder a las solicitudes de los reguladores, Chiquita y sus consultores han vuelto a evaluar el problema en varias ocasiones el último año y los análisis y las conclusiones sobre la viabilidad y la protección de la barrera vertical solicitada han empeorado. La barrera vertical solicitada no solo continúa demostrando ser inviable para ser instalada, tanto por motivos técnicos como por motivos de seguridad, sino que además su instalación alteraría las medidas de mitigación existentes de Chiquita que han estado manejando la reacción de forma efectiva. Esta disrupción podría empeorar las condiciones de la reacción, como se ilustra en la extensión de la cubierta de geomembrana conforme a la Orden, y los impactos resultantes en las temperaturas.

[2] La obra involucró completar este análisis de estabilidad de la pendiente, que incluye de forma enunciativa más no limitativa, recopilación de datos, revisión y consolidación de datos, preparación de gráficos, construcción de modelo y ejecución de análisis y preparación y finalización del informe.

[3] *Consulte* Evaluación y Certificación del Sistema de Tanques de Desechos Peligrosos de Ingenieros Profesionales elaborado por SCS Engineers el 19 de noviembre de 2025.

[4] Vertedero de Chiquita Canyon - Análisis de Estabilidad Estática y Sísmica Global del Sistema de Tanques de Desechos Peligrosos Propuesto, elaborado por SCS Engineers el 27 de noviembre de 2025.

que incluyeron un informe con fecha de febrero de 2024 que llegaron a la conclusión de que "el potencial de una futura inestabilidad que afecte el sistema de contención subyacente del vertedero es bajo", que "no se justifican otras medidas de mitigación a corto plazo" y que "tampoco se justifican métodos a plazo más largo para mejorar la estabilidad."[5] En otro informe con fecha de agosto de 2024, el perito de Chiquita llegó a la conclusión de que "Los resultados de esta evaluación indican que la zona reactiva no tiene un efecto que pueda medirse en la pendiente apuntalada orientada hacia el sur del Vertedero que está debajo del Módulo 4, el Módulo 5 y la Celda 8".[6] Chiquita además presentó un Plan de Trabajo de Análisis de Estabilidad de la Pendiente a US EPA el 27 de marzo de 2024 que la agencia aprobó el 13 de junio de 2024.[7] Por último, el 11 de diciembre de 2024, el perito de Chiquita llegó a la conclusión en un análisis técnico sobre la estabilidad del Vertedero que "los datos muestran que la estabilidad de la pendiente sur del Vertedero y la zona de la Celda 8B no se ven impactadas negativamente por la reacción".[8] Todos estos modelados y análisis previos sobre la estabilidad de la pendiente explicaron la estabilidad sísmica y colectivamente concluyeron que no hay problemas de estabilidad en el Vertedero en este momento.

El DTSC también solicitó que Chiquita presente un Programa Maestro preliminar bajo la Orden. El 28 de octubre de 2025, Chiquita solicitó una extensión hasta el 21 de noviembre de 2025 para presentar el Programa Maestro preliminar junto a esta respuesta. Chiquita proporciona en el **Adjunto A** un Programa Maestro preliminar que contiene actividades relevantes previstas para el Vertedero y documenta las fechas en las que Chiquita le dio acceso a los datos al DTSC.

Antes de responder a cada comentario del DTSC y de CalRecycle en este documento, Chiquita proporciona el siguiente análisis que trata varios conceptos erróneos recurrentes y solicita que se crea en él, en base a la mayoría de los comentarios del DTSC y de CalRecycle.

Los Eventos de Vertedero de Temperaturas Elevadas son Eventos a Largo Plazo con Soluciones Limitadas

Ha habido varios eventos de Vertedero de Temperatura Elevada (ETLF) a gran escala en América del Norte documentados en los últimos 20 años. Los eventos de ETLF se refieren a ciertas características de biogás o lixiviados que resultan de procesos bacterianos anaeróbicos prolongaos y generalmente ocurren en desechos saturados profundos, que dan como resultado una mayor producción de lixiviados, una mala composición de biogás y mayores temperaturas.[9] Mientras que cada evento de ETLF es único, su estudio académico ha llevado a comprender mejor los ciclos de vida de los eventos de ETLF que cada vez son más aceptados en las comunidades académicas, de la industria y reguladoras.

Los mecanismos subyacentes que "inician" un evento de ETLF varían, aunque algunos ETLFs tienen su causa raíz en la aceptación de desechos industriales específicos, como Residuos de Combustión de Carbón o Desechos de Procesamiento de Aluminio. En estos casos, los desechos industriales saturados pueden pasar por una reacción química,

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[5] Análisis de Estabilidad de la Pendiente Oeste y Norte, Proyecto No. RM23.1077.00, elaborado por Geo-Logic Associates en febrero de 2024.
[6] Análisis de Estabilidad del Plan de Desarrollo Maestro, Proyecto No. RM22.1077.00, elaborado por Geo-Logic Associates el 23 de agosto de 2024.
[7] *Consulte el* Plan de Trabajo para el Análisis de la Estabilidad de la Pendiente de Geo-Logic Associates del 14 de diciembre de 2023. La LEA también emitió una carta aceptando condicionalmente el Plan de Análisis de Estabilidad de la Pendiente el 20 de diciembre de 2023.
[8] Carta a la Junta Regional de Control de la Calidad del Agua de Los Ángeles, Chiquita Canyon, LLC – Solicitud de Reconsideración del Rechazo del 25 de septiembre de 2024 a la Autorización para Colocar Desechos en la Celda 8B del 11 de diciembre de 2024.
[9] *Consulte, por ejemplo*, M. Krause, et al., Comprendiendo el Comportamiento del Biogás en Vertedero de Temperaturas Elevadas, Gestión de Desechos (2023) 165.

que puede producir calor. A medida que se va desplegando un evento de ETLF, la producción de gases y lixiviados generalmente abruman los sistemas de extracción de gases y líquidos permitidos. Este rápido aumento de líquido de desechos además puede obstaculizar los sistemas de recolección y control de gas.

Un evento de ETLF además puede afectar el asentamiento típico del vertedero.[10] En general, cuando se dispone de desechos, ocurre una fase de asentamiento inicial debido al peso de los desechos que se ponen sobre los desechos existentes y el peso sumado de las maquinarias pesadas, como compactadoras y topadoras, que se utilizan para colocar los desechos. Posteriormente hay una consolidación primaria, ya que la descomposición continua genera la remoción de gases y líquidos. Durante un evento de ETLF, el asentamiento inicial y la consolidación primaria ya ocurrieron. A medida que va progresando la reacción, el material de desecho podrá pasar por degradación térmica. Una vez degradados térmicamente, estos materiales pueden causar un asentamiento diferencial, aunque no siempre.

Hay un período del ciclo de vida de un evento de ETLF en el que el material de desecho pasó por alguna forma de hidrólisis celulósica, dando como resultado la generación de grandes cantidades de lixiviados. Estos lixiviados acumulados residen en los espacios porosos de la masa de desechos. Como se mencionó previamente, esto genera una mayor presión interna dentro de la masa de desechos; con perspectiva de asentamiento, estos lixiviados ayudan a sustentar la masa de desechos hasta que se extrae, momento en el que ocurre el asentamiento final.

Podrá ser necesaria una infraestructura importante para extraer y transportar las cantidades de gases y líquidos. Con el tiempo, la producción de lixiviados declina, pero podrán quedar temperaturas más altas. Es importante distinguir entre la existencia de temperatura y generación continua de calor, ya que se sabe que los vertederos de desechos sólidos municipales tienen una alta capacidad de retención de calor. El material reaccionado retiene su calor y se enfría en una curva en disminución pero no continúa reaccionando ya que no queda nada de material crudo por reaccionar. En estas instancias y donde la geometría del vertedero fue permisiva, algunos operadores del vertedero han instalado o dejaron una "brecha de aire" para separar el área impactada por el evento de ETLF del resto del vertedero, para limitar la capacidad de migración de lixiviados hacia nuevas áreas y saturar aún más los desechos industriales.[11] Sin embargo, la "brecha de aire" no es apropiada en el Vertedero debido a la geometría relativa de las celdas del Vertedero en las que se instalaría la brecha de aire y por la profundidad de los desechos existentes y la cantidad pura de materiales de desecho que debería removerse. Considerando la magnitud de la instalación requerida, lograr construir una brecha de aire tomaría varios años y podría dar como resultado más olores y riesgos de potenciales incendios. Esta instalación además perturbaría y dificultaría las medidas de mitigación existentes e imperativas de Chiquita para manejar la reacción.

La Barrera Vertical Solicitada No es una Solución Viable para Chiquita

La barrera vertical solicitada no sería efectiva para el Vertedero debido a las características de esta reacción y a las condiciones específicas del sitio del Vertedero. Un informe de los consultores de Chiquita, SCS

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[10] *Consulte, por ejemplo,* M. Krause, When Does a Municipal Solid Waste Landfill become an Elevated Temperature Landfill (ETLF)? (¿Cuándo un vertedero de desechos sólidos municipales se convierte en un vertedero de temperatura elevada [ETLF]?) , U.S. EPA, Washington, DC, EPA/600/R-21/285, 2022, *disponible en* https://www.epa.gov/system/ *files/documents/2022-04/elevated-temperature-landfills-factsheet-1.pdf.*

[11] Una "brecha de aire" es un espacio vacío de "aire abierto" contiguo a una zona reactiva con el propósito de impedir el flujo de calor difuso de una parte de la masa de desechos a otra. *Consulte* Plan de Quiebre/Barrera de suelo de la Reacción, elaborado por SCS Engineers el 26 de noviembre de 2024.

Engineers (SCS), evaluó las potenciales causas raíz del evento de ETLF y descubrió que Chiquita nunca aceptó flujos de desechos del mismo tipo que el identificado en otros vertederos que experimentaron eventos de ETLF.[12] Además, la extracción de lixiviados a través del sistema de recolección de lixiviados (LCS) normalmente permitida no varió significativamente generando el evento de ETLF ni cambiaron los parámetros en el flujo de desechos que sugieran un evento de ETLF. Por lo tanto, se pueden deducir varias observaciones importantes:

- El activador típico de un evento de ETLF no ocurrió en el Vertedero y la propagación de lixiviados a otras áreas del Vertedero no fue el único contribuyente a la reacción.
- Los flujos de desechos que estuvo aceptando el Vertedero mientras todavía aceptaba desechos no activó el evento de ETLF.
- Hay algo de inhibición de filtración de lixiviados hacia abajo del sistema del revestimiento y posteriormente al LCS.
- Contratistas de Chiquita han perforado las profundidades especificadas en la zona reactiva dirigida por datos y descubrió varias capas de piedra gruesa de hasta 10 pies de espesor, que varían en elevaciones de 1,100 a 1,250 pies promedio del nivel del mar.

Mientras que el activador del evento de ETLF de Chiquita no puede atribuirse a la aceptación de desechos específicos, parece ser que el crecimiento de la reacción podría atribuirse a hidrólisis exotérmica autosostenida. Autosostenida, en esta instancia, significa que el gas y los subproductos líquidos de la reacción están causando más temperatura y acumulación de calor.

Por lo tanto, parecería ser que probablemente las capas de piedra dentro de la masa de desechos obstaculizaron la extracción gases y líquidos, eventualmente causando acumulación de calor que creció hacia un punto en el que "subió" alguna cantidad discreta de desecho por encima de los límites de presión y temperatura, creando una reacción de hidrólisis exotérmica autosostenida. Este entendimiento nos hace llegar a las siguientes conclusiones:

- El tipo de "relleno de cañón" de Chiquita de la masa de desechos no conduce a una brecha de aire ni a otra barrera vertical. La barrera vertical que propone el Dr. Stark no se probó nunca, ni hablar de su que se haya demostrado su efectividad.
- La instalación de la barrera vertical solicitada debe ser evaluada para ver si tendrá algún efecto negativo en las medidas de mitigación existentes que se están tomando en el Vertedero. Como ejemplo, la instalación de la barrera vertical solicitada indudablemente causaría disrupción en los trabajos de extracción de gases y líquidos en curso en el Vertedero.
- Dado que la acumulación de gases y líquidos componen la acumulación de calor y presión, la disrupción de los esfuerzos de extracción de gases y líquidos de Chiquita es contraproducente y debería evitarse.

<u>Instalar La Barrera Vertical Solicitada es Técnicamente Viable</u>

El DTSC y CalRecycle no han demostrado cómo podría instalarse la barrera vertical solicitada de forma que mitigue la reacción de forma efectiva. El DTSC y CalRecycle dicen que

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[12] SCS Engineers en nombre de Chiquita, *Informe de la Investigación de la Causa de Vertedero de Temperaturas Elevadas* (8 de diciembre de 2023) en la página 9.

no sería necesario instalar la barrera vertical solicitada a las profundidades que detalla Chiquita en el RAW preliminar para contener la reacción e indican que calibres poco profundos serían suficientes.[13] Sin embargo, debido a las temperaturas pico de la reacción que están por debajo del nivel de líquido en la masa de desechos, calibres relativamente poco profundos no evitarían la propagación del calor y la reacción debajo de los calibres; serían necesarios bocas de pozo y pozos profundos. Reconociendo que el área reactiva está dentro de los desechos saturados y por debajo del nivel de líquidos dentro de la masa de desechos y por lo tanto se necesitarían calibres de pozos y pozos más profundos, se necesitarían plataformas de perforación sónica ya que las plataformas de perforación convencionales no pueden perforar profundo en la zona reactiva sin colapsar en la boca del pozo. Las plataformas de perforación sónicas asientan el revestimiento al perforar, para mantener la perforación abierta, permitiendo que estos pozos se perforen por el líquido. Este método de perforación aumentaría mucho la cantidad de tiempo requerida para crear la barrera vertical solicitada, ya que las perforaciones sónicas tienen un diámetro máximo de un pie y no de tres pies, requiriendo una mayor cantidad de perforaciones que deberían estar hasta 250 pies de profundidad. En base a las experiencias de los ingenieros de Chiquita en otros sitios de ETLF, completar cada perforación podría requerir aproximadamente tres días. Esto aumenta drásticamente los plazos para la instalación de la barrera vertical solicitada en una magnitud de años, incluso si se utilizaron varias plataformas de perforación para completar el proyecto.

Otro problema es que las perforaciones del vertedero de forma rutinaria dan como resultado el rechazo o bloqueo de la perforación por entierros de desechos pasados (acero, concreto, etc.) no permiten que una perforación continúe hasta su profundidad completa. En estas instancias, generalmente se coloca una perforación de pozo cerca para que la perforación pueda llegar a su profundidad total. Sin embargo, para lograr una barrera uniforme a por la perforación, no podrían reubicarse las ubicaciones de los pozos, siendo poco práctico, o tal vez imposible, perforar dentro de los vertederos. Además, perforar pozos profundos con una circunferencia que se entromete en un "hueco" de perforación existente no es factible porque la barrena migrará de preferencia al pozo anterior. Como resultado, estos riesgos anticipados en la aplicación en el campo limitan significativamente la viabilidad y la efectividad de la barrera vertical solicitada.[14]

<u>Instalar La Barrera Vertical Solicitada es Poco Seguro</u>

El DTSC y CalRecycle también han tratado los varios problemas de seguridad y riesgos para la salud humana y el medioambiente que Chiquita elevó en varias ocasiones, que darían resultarían de la instalación de la barrera vertical solicitada.

Considerando la magnitud de instalación necesaria para la barrera vertical solicitada, este tipo de esfuerzo probablemente daría como resultado importantes emisiones de biogás fugitivo y una potencial exposición de personal de la construcción a condiciones potencialmente peligrosas asociadas a biogás, lixiviados y materiales de desechos expuestos. La exposición de materiales de desechos enterrados a condiciones atmosféricas, además de la operación del sistema de recolección de biogás activo, aumentaría la probabilidad de que haya potenciales incendios (tanto en la superficie de la instalación como dentro de la subsuperficie que la rodea). Lo más importante, como se explicó arriba, es que cualquier instalación a lo largo de la extensión horizontal del límite de la reacción dirigido por datos perturbaría y dificultaría las operaciones del sistema de recolección del vertedero y

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[13] *Consulte el* Comentario Técnico de CalRecycle No. 3 ("El consultor de CCL indica que las perforaciones del suelo de la barrera de corte debería estar a más de 200 pies de profundidad y esto no es viable. Esto nuevamente es confuso, dado que los desechos en la interfaz entre las Celdas 6 y 8 están aproximadamente a 80 pies de profundidad y es realmente algo puede alcanzarse").

[14] Para observar otro análisis de la poca viabilidad técnica de la berrera vertical solicitada, consulte el Plan de Quiebre/Barrera de Suelo de la Reacción elaborado por SCS Engineers el 26 de noviembre de 2024.

el sistema de desagüe del campo de pozos, siendo ambos imperativos para mitigar las condiciones de ETLF.[15] La instalación de este tipo de barrera también requeriría que Chiquita reduzca la extracción de biogás para evitar la intrusión de oxígeno. La eliminación del calor a través de la extracción de gas de vertedero es una medida de mitigación crucial y reducirla sería perjudicial para los esfuerzos en curso para contener la reacción. Además, una reducción en el vacío en las áreas que están alrededor de la barrera daría como resultado más emisiones, sin certeza de que esta medida tenga un impacto apreciable en impedir la potencial propagación de la reacción.

<u>La Reacción es Estable</u>

Chiquita no está de acuerdo con las alegaciones del DTSC que indican que "hay un aumento obvio en las temperaturas máximas en varias profundidades" y que "la reacción está creciendo".[16] En una revisión de los mapas de temperatura vertical máxima de treinta días presentados a la Agencia de Cumplimiento Local (LEA) el año pasado, hemos observado que las temperaturas capturadas por las sondas de monitoreo de temperatura se han mantenido relativamente consistentes.[17] Los informes de la Determinación de la Zona Reactiva además muestran que las condiciones de ETLF continúan siendo generalmente consistentes con la delineación inicial desarrollada en octubre de 2023.[18] El Comité de la Reacción ha instituido solo ajustes leves y discretos periódicos al límite de la zona reactiva dirigida por datos (línea magenta) para incorporar pozos y sondas de biogás individuales selectas y no ha habido ajustes en el límite de la Zona Reactiva de la Condición 9(a) (línea negra).[19]

CalRecycle también declara que la reacción se ha expandido. CalRecycle cita dos pozos, el CV-113 y el CV-24011, e indica que a julio de 2025 ambos indican que la reacción se ha propagado a áreas fuera del límite dirigido por datos.[20] Desde ese momento, el Comité de la Reacción ha ajustado el límite dirigido por datos para incluir el CV-24011 en agosto de 2025, descubriendo que se justificaba un ajuste de 25 pies debido a la mala calidad del biogás observada, a las lecturas de las temperaturas y a la corta proximidad de las condiciones de la reacción

[15] Para consultar otros análisis de los riesgos de la barrera vertical solicitada para la salud humana y el medioambiente, consulte el Plan de Quiebre/Barrera de Suelo de la Reacción, elaborado por SCS Engineers el 26 de noviembre de 2024.
[16] *Consulte el* Comentario General No. 3 del DTSC.
[17] *Consulte la* Orden de Cumplimiento de la LEA del 6 de junio de 2024; la carta de respuesta de la LEA con fecha 29 de mayo de 2024; la directiva de la LEA No. 2(d) con fecha 5 de abril de 2024; y las Presentaciones y los Informes Semanales de las Sondas de Monitoreo de Temperatura del 3 de mayo de 2024 - actualización del 13 de junio de 2024, 21 de junio de 2024 - actualización del 1 de agosto de 2024, 26 de julio de 2024 - actualización del 5 de septiembre de 2024, 16 de agosto - actualización del 26 de septiembre de 2024, 30 de agosto - 30 de agosto - actualización del 10 de octubre de 2024, 26 de septiembre - actualización del 6 de noviembre de 2024, 24 de octubre - actualización del 4 de diciembre de 2024, 28 de noviembre, actualización del 8 de enero de 2025, 26 de diciembre - actualización del 5 de febrero de 2025, 27 de febrero - actualización del 5 de marzo de 2025, 27 de marzo - actualización del 2 de abril de 2025, 1 de mayo - actualización del 7 de mayo de 2025, 29 de mayo - actualización del 4 de junio de 2025, 3 de julio - actualización del 9 de julio de 2025, 31 de julio - actualización del 6 de agosto de 2025, 28 de agosto - actualización del 3 de septiembre de 2025, 2 de octubre de 2025 - actualización del 8 de octubre de 2025 y 30 de octubre de 2025 - actualización del 5 de noviembre de 2025.
[18] Declaración de Robert Dick, en el Asunto del Caso No. 6177-4 del Distrito de Gestión de la Calidad del Aire de la Costa Sur vs. Chiquita Canyon, LLC, presentado ante la Junta de Audiencias del Distrito de Gestión de la Calidad del Aire de la Costa Sur el 22 de octubre de 2025.
[19] *Consulte las* Determinaciones del Comité de la Reacción elaborado por SCS Engineers el 6 de octubre de 2023, el 6 de noviembre de 2023, el 6 de diciembre de 2023, el 5 de enero de 2024, el 7 de febrero de 2024, el 7 de marzo de 2024, el 5 de abril de 2024, el 7 de mayo de 2024, el 7 de junio de 2024, el 5 de julio de 2024 el 7 de agosto de 2024, el 6 de septiembre de 2024, el 7 de octubre de 2024, el 7 de noviembre, el 10 de diciembre de 2024, el 10 de enero de 2025, el 10 de febrero de 2025, el 10 de marzo de 2025, el 10 de abril de 2025, el 9 de mayo de 2025, el 10 de junio de 2025, el 10 de julio de 2025, el 9 de septiembre de 2025 (revisado, el 10 de septiembre de 2025, el 10 de octubre de 2025 y el 10 de noviembre de 2025.
[20] *Consulte la* carta de CalRecycle al DTSC, Comentarios sobre el Plan de Acción para Extracción Preliminar para Proteger la Celda 8A de un Evento de Intrusión de Vertedero de Temperaturas Elevadas, 12 de septiembre de 2025 en 2.

hacia el norte. Las temperaturas de CV-113 han bajado drásticamente desde octubre de 2025, pero regresaron sus niveles de metano. Las temperaturas fluctúan todos los meses y un pozo que exhibe temperaturas más altas un mes podrá exhibir temperaturas más bajas el mes siguiente. Esto es precisamente por qué el Comité de la Reacción considera varios puntos de datos y parámetros diferentes antes de ajustar el límite dirigido por datos y respalda la posición de Chiquita de que la reacción no es un evento estático. Fluctúa, por lo tanto es necesario que se confirme si hay una tendencia hacia condiciones de reacción antes de ajustar el límite dirigido por datos.

De hecho, como se explica en los dos párrafos siguientes, el Comité de la Reacción está viendo señales de que la reacción se está contrayendo en ciertas áreas.[21] Durante el trascurso de las determinaciones de la zona reactiva, el Comité de la Reacción también considera si hay áreas de la reacción donde la masa de desechos se esté enfriando. Como abundancia de precaución, el Comité de la Reacción todavía no quitó ninguna de estas áreas de la Zona Reactiva, pero ha identificado las áreas descritas a continuación donde está observando mejoras en las condiciones del ETLF.

Como se exhibe en los mapas de rango de gradiente isotérmico que se incluyen como Adjunto C de los informes mensuales sobre la determinación de la zona reactiva, las temperaturas de los cabezales de pozos de biogás registradas cada mes demuestran varias subáreas dentro del límite dirigido por datos que exhiben consistentemente temperaturas sustancialmente más bajas que otros cabezales de pozos dentro de este límite. Una subárea está posicionada en la parte sur-central de la zona reactiva dirigida por datos y otro está posicionado en la parte este-central. Ambas subáreas contienen pozos que exhiben temperaturas por debajo de los 145 °F y muchas son tan bajas como 130 °F. El Comité de la Reacción continúa revisando y analizando los datos registrados en los pozos dentro de estas subáreas para evaluar si varios parámetros operativos indican que la gravedad de la reacción se está reduciendo dentro de estas subáreas, como se evidencia con la reducción de temperaturas, aumentando las relaciones de metano a dióxido de carbono y la reducción del contenido de hidrógeno en pozos selector dentro de estas subáreas.[22]

El Comité de la Reacción también ha identificado reducciones específicas en ciertas sondas de monitoreo de temperatura, que incluyen las que se encuentran dentro de la zona reactiva. Como se informó en la determinación de agosto de 2025, la TP-8 exhibió reducciones en la temperatura de aproximadamente 10 °F durante un período de seis semana casi en todos los intervalos de profundidad. Por ejemplo, la temperatura en la termocupla de la TP-8 a 150 pies de profundidad se redujo de aproximadamente 178°F a 168°F.[23] También hubo importantes reducciones en julio de 2025 en las temperaturas máximas, en dos sondas de monitoreo de temperatura ubicadas dentro de la extensión estimada de las condiciones de ETLF.[24] La temperatura máxima de TP-9 se redujo de 219 °F a 209 °F durante el período de 4 semanas del 26 de junio al 24 de julio de 2025.[25] La temperatura máxima de TP-

[21] *Consulte, por ejemplo*, la Determinación del Comité de la Reacción elaborado por SCS Engineers el 8 de agosto de 2025 en 4-5 (destacando importantes reducciones en las temperaturas máximas en sondas de monitoreo de temperatura especificadas ubicadas dentro de la extensión estimada actual de condiciones de ETLF).
[22] *Consulte la* Declaración de Robert Dick, *arriba* en la referencia anterior. 31 en ¶ 18.
[23] *Id.* en ¶ 19.
[24] *Id.*
[25] *Id.*

21 se redujo de 255 °F a 214 °F durante el período de 12 semanas del 1 de mayo al 24 de julio de 2025.[26] TP-9 y TP-21 se han mantenido consistentes desde que experimentaron la reducción en la temperatura.[27]

En su determinación más reciente que abarca el mes de octubre de 2025, el Comité de la Reacción ajustó el límite dirigido por datos para incorporar un área pequeña diferente que está inmediatamente contigua al límite en dirección noreste. Este ajuste involucró un aumento en el tamaño del área dentro del límite dirigido por datos de aproximadamente un 2.33 por ciento de la determinación del Comité de la Reacción del mes anterior.[28] Este ajuste incluyó tres pozos de extracción de biogás (CV-2333, CV-24126 y CV-25100S/D) y una sonda de monitoreo de temperatura (TP-18). Este ajuste menor no está en la dirección de la ubicación de la barrera vertical solicitada ni en las celdas del Vertedero y se hizo después de haber considerado atentamente varios flujos de datos. Además, Chiquita cree que la expansión reciente de la cubierta de geomembrana conforme a la Orden contribuyó al ajuste menor de la línea del límite dirigido por datos. Como parte del despliegue de cubierta de geomembrana adicional, Chiquita tuvo que sacar de servicio todos los pozos de extracción de biogás y bombas de desagote de las áreas de despliegue de cubierta activas para completar la instalación de la cubierta debido a que la cubierta debe instalarse debajo de las tuberías e infraestructura existentes, requiriendo la remoción de partes de la tubería para dar acceso a la instalación. Como resultado de sacar de línea todos los pozos de extracción de biogás y bombas de desagote en las áreas de despliegue de cubiertas activo, Chiquita vio un aumento en los olores en el sitio y en las temperaturas. Estos olores en el sitio y temperaturas volvieron a bajar apenas los pozos de extracción de biogás y las bombas de desagote de las áreas de despliegue de cubiertas activo volvieron a estar en línea.

La evaluación general de la zona reactiva dirigida por datos debería considerar tanto los ajustes recientes en la zona del límite como las áreas donde estamos observando mejoras en la temperatura y en otros datos. No es preciso caracterizar la reacción como que únicamente se está expandiendo; aunque el Comité de la Reacción ajustó el límite de la zona reactiva dirigido por datos, hay espacios de áreas más frescas dentro de la zona reactiva que ya no están exhibiendo evidencia definitiva de una reacción, como se describió arriba. Los ajustes representan con mayor precisión la probabilidad de que el calor y el gas de la reacción puedan moverse por los esfuerzos agresivos de desagüe que se están realizando a lo largo del límite de la zona reactiva hacia áreas donde el proceso de metanogénesis continúa siendo el mecanismo rector que controla la descomposición. Hay diferentes grados de gravedad para impedir e interferir con la metanogénesis, que puede pensarse con mayor precisión como que ocurre en un espectro y no como un evento binario.

La reacción es estable. Aunque el DTSC no forma parte de la Orden Estipulada, el Comité de la Reacción analiza una plétora de flujos de datos para llegar a esta conclusión todos los meses. La eficacia y la precisión de este ejercicio no debe discontinuarse solo porque el DTSC no desea creer en las

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[26] *Id.*
[27] *Id.*
[28] Desde enero de 2025, el tamaño del límite dirigido por datos solo cambió en tres ocasiones: en mayo de 2025 (aumento de aproximadamente un 6.9 por ciento); en agosto de 2025 (aumento de aproximadamente un 0.44 por ciento) y en octubre de 2025. El tamaño de la zona reactiva no cambió en febrero, marzo, abril, junio, julio o septiembre de 2025 Los aumentos observados en mayo, agosto y octubre de 2025 son todos cambios menores que no consideran las potenciales contracciones de la zona reactiva.

conclusiones del Comité de la Reacción.[29] Si la agencia está preocupada por la confiabilidad de las Determinaciones del Comité de la Reacción, Chiquita destaca que el AQMD de la Costa Sur, como agencia que ordenó estos informes y los revisó cada mes, no ha elevado ningún problema con respecto a la validez de las conclusiones de estos informes. Además, todos los datos que utiliza el Comité de la Reacción para formar las bases de sus análisis y conclusiones están completamente disponibles dentro del mismo informe. Las solicitudes del DTSC de datos crudos o de un "set de datos más profundo" no le dan acceso al DTSC a ningún otro dato de lo que ya se informó en las Determinaciones del Comité de la Reacción, que son datos a los que el DTSC ya tiene acceso porque revisa el informe todos los meses. El hecho de que el DTSC no forme parte de la Orden Estipulada no menoscaba la revisión externa confiable y objetiva conducida por el Comité de la Reacción y por el AQMD de la Costa Sur todos los meses en conformidad con la Orden Estipulada.

<u>La Temperatura Sola no es un Indicativo de Condiciones de Reacción</u>

Como reconoce el DTSC en sus comentarios, la temperatura sola no es un determinante de condiciones de reacción.[30] Sino que se monitorea constantemente una multitud de parámetros y puntos de datos para determinar si en su conjunto la reacción se está expandiendo. Esto incluye parámetros y puntos de datos que evalúan la composición del gas, como la relación de metano y dióxido de carbono, hidrógeno, metano y monóxido de carbono. También deben considerarse otros factores, como un asentamiento acelerado, el valor de deformación, las cantidades de exceso de lixiviados, las liberaciones de líquidos presurizados los olores, las observaciones de las condiciones y las características de los desechos en la subsuperficie y otros factores, junto con los datos de las temperaturas y de la composición de los gases. Por lo tanto, varios de los comentarios del DTSC y de la Orden, que llegan a la conclusión de que la reacción se está expandiendo únicamente en base a la temperatura, son de hecho incorrectos.

<u>Las Medidas de Mitigación En Curso de Chiquita son Altamente Efectivas y No Deben Verse Perjudicadas</u>

En consulta y bajo la estrecha supervisión de sus numerosos reguladores, Chiquita está implementando varias medidas sin precedentes para minimizar la propagación de la reacción y abordar cualquier impacto potencial de la reacción. Estas medidas de mitigación han demostrado ser altamente efectivas y son imperativas para el manejo de la reacción. Ninguna alternativa explorada o implementada debe impedir la efectividad de las medidas de mitigación existentes de Chiquita.

Sistema de Recolección y Control de Gases de Vertedero

El sistema de recolección y control de gas de vertedero de Chiquita está diseñado para minimizar las emisiones fugitivas de gas de vertedero. Las zanjas horizontales de recolección de gas de vertedero y los pozos verticales de extracción de gas de vertedero están conectados a un sistema de cabecera central (tubería) que transporta el gas de vertedero a las antorchas, donde los compuestos olorosos se convierten en derivados inofensivos, dióxido de carbono y vapor de agua. Chiquita instaló tres oxidantes térmicos (TOx) en el Vertedero para que ayuden a las tres antorchas existentes a que hagan la combustión completa del biogás proveniente de la zona reactiva. Las TOx le permiten a Chiquita tener una mayor capacidad de control

[29] De hecho, el DTSC debería estar contento con la Determinación más reciente del Comité de la Reacción, con la que el Comité ajustó el límite dirigido por datos. El Comité de la Reacción o participa en este análisis mensual solo para repasar las mociones de cumplir con la SOFA. Realiza un análisis rigurosos sujeto a una aprobación y acuerdo unánime antes de que se saquen conclusiones.

[30] *Consulte el* Comentario General No 4 del DTSC ("Es verdad que el solo uso de la temperatura como medición para el determinar el límite de la reacción podrá producir prejuicios...")

(es decir, su capacidad para quemar gas de vertedero para quemar componentes, reduciendo su emisión a la atmósfera) en un plazo más rápido que el plazo para la autorización y construcción de una nueva antorcha. El TOx también es más capaz que las antorchas de convertir los constituyentes del gas de reacción en dióxido de carbono y vapor de agua.

La extracción de gas de vertedero es un aspecto importante para ayudar a controlar la migración fuera del sitio del gas de vertedero y el posterior potencial de que los olores lleguen a una comunidad, y para reducir la propagación y la generación de calor asociada con la reacción. Chiquita ha ampliado su sistema de recolección y control de gas de vertedero para abordar el gas de reacción. Desde el 6 de diciembre de 2023, además de operar una nueva antorcha de gas de vertedero y dos nuevos TOX, Chiquita ha instalado más de 315 nuevos pozos verticales de extracción de gas de vertedero. Desde el 1 de diciembre de 2023, Chiquita también ha instalado aproximadamente 67,5 millas de tubería en todo el vertedero. Este trabajo está en curso, y se están diseñando y planificando pozos adicionales, tuberías y otros dispositivos de control (p. ej., antorchas) para su instalación en 2026.

La extracción de lixiviados de vertedero es otra medida clave para reducir la propagación y el impacto de las reacciones de los vertederos y eliminar el lixiviado asentado del vertedero. Chiquita está instalando bombas de desagüe en sus pozos verticales de extracción de gas del vertedero para bombear el lixiviado asentado fuera del vertedero. Al 14 de noviembre de 2025, Chiquita ha instalado y comenzado a operar bombas en más de 146 pozos, y este número sigue aumentando. Como resultado de la instalación de la tubería adicional, de pozos de extracción vertical de biogás y de bombas de desagote, Chiquita ha estado extrayendo aproximadamente 137 millones de galones de líquido desde el 1 de enero hasta el 9 de noviembre de 2025.[31] La extracción continua y agresiva de líquidos de vertederos que experimentan eventos de ETLF es muy importante en su gestión y contención.

Cubierta Geosintética

La cubierta geosintética existente es un revestimiento de 30 milésimas de pulgada (0.030 pulgadas) de HDPE (es decir, de plástico), instalada sobre las pendientes oeste y norte y la cubierta superior del área de reacción. Se han instalado colectores de gas de vertedero superficiales (tuberías perforadas que quedan planas en el suelo) debajo de la cubierta para permitir la recolección de gas entre la superficie del vertedero y la cubierta geosintética. Se colocó tierra en ciertas áreas sobre la cubierta de geosintéticos para protegerla y permitir que los vehículos accedan al área. Una serie de desagües pluviales y zanjas revestidas controlan el drenaje superficial desde la cubierta y dirigirán las aguas pluviales a las estructuras de control existentes.

El 21 de julio de 2025 Chiquita comenzó el proceso de instalar cubierta de geomembrana adicional en cumplimiento con la Orden. Como lo indica la Orden, la cubierta está hecha de HDPE y tiene un núcleo interno hecho de resina que forma una barrera de alcohol vinílico de etileno (EVOH). Esta cubierta de geomembrana de EVOH/HDPE tiene 60 milésimas de pulgada (0.060 pulgadas) de espesor, lo que significa que es más resistente al desgaste y a los desgarros generales y que es de color marrón y es texturada en ambos lados. Las nuevas áreas de despliegue de geomembrana estarán contiguas y unidas a la cubierta de geomembrana de HDPE de 30 milésimas de pulgada preexistente. Chiquita también ha instalado colectores de biogás

[31] Orden de Depuración Estipulada, Caso No. 6177-4, Condición 53 Informe Semanal, 12 de noviembre de 2025 (se puede acceder desde https://s3.us-west-1.amazonaws.com/chiquitacanyon.com.bucket/2025/11/2025-11-12-Case-No_-6177-4-Stipulated-Order-for-Abatement-%E2%80%93-Condition-53-Weekly-Report-1.pdf).

debajo de la cubierta de geomembrana de EVOH/HDPE. Al 14 de noviembre de 2025, Chiquita ha instalado aproximadamente otros16 acres de esta cubierta de geomembrana de EVOH-HDPE.

Chiquita espera que esta cubierta de geomembrana adicional aumente la eficacia del sistema de recolección de gases del vertedero y, por lo tanto, ayude a controlar más los potenciales olores al limitar las emisiones superficiales del vertedero.

La instalación del drenaje de talud oeste

Este proyecto facilita el drenaje de lixiviados y la recolección adicional de lixiviados a lo largo de la pendiente oeste del vertedero, mejora la recolección de gas al completar la instalación de la cubierta geosintética y permite que las aguas pluviales recolectadas en la parte superior del revestimiento fluyan directamente al canal de aguas pluviales de concreto.

Para hacerlo, se instalaron un nuevo drenaje en la base y un drenaje secundario y se reemplazó la cubierta plástica temporal por una cubierta geosintética. Un drenaje de talud es un sistema que recolecta y dirige el agua o los lixiviados desde la pendiente de un vertedero hasta un lugar designado para su eliminación. Para instalar el drenaje de talud permanente y el revestimiento, Chiquita excavó en un área de unos 55,000 pies cuadrados (lo que representa un volumen de aproximadamente 14,000 yardas cúbicas de tierra y desechos enterrados). Este proyecto asegura el éxito continuo de los agresivos esfuerzos de Chiquita de extracción de líquidos, permitiendo la práctica recolección de líquidos para su remoción.

Sondas de Control de Temperatura de Residuos

Una medida crítica utilizada por Chiquita y sus consultores para evaluar la reacción es la temperatura de los residuos dentro y alrededor del área de reacción. Chiquita instaló sondas de monitoreo de temperatura de los desechos (denominadas TMPs, TPs o sondas) dentro y alrededor de la zona reactiva, para monitorear las temperatura de los desechos en profundidades variadas dentro de la masa de desechos del Vertedero. Al 14 de noviembre de 2025, Chiquita ha instalado 39 sondas para monitorear estas temperaturas de forma continua. Las sondas adicionales permiten que Chiquita monitoree atentamente los cambios en la temperatura, que junto con otros cambios observados, podrían indicar una expansión de la reacción.

Agregados Recientes

Chiquita ha agregado otras varias medidas a su estrategia de gestión de la reacción, que incluyen tres pozos de monitoreo subterráneo nuevos (dos en el sitio y uno fuera del sitio), un sistema de nebulización para el control de olores perimetrales para reducir potenciales olores en las comunidades cercanas y diez unidades de monitoreo de aire por micro cromatógrafo de gases que incluyen en seis de siete de las estaciones de monitoreo de aire previamente instaladas en comunidades cercanas, que monitorean los constituyentes del aire las 24 horas del día, los siete días de la semana.

En resumen, la combinación de estas mejores prácticas de gestión para tratar la reacción ha permitido que Chiquita monitoree y gestione la reacción de forma efectiva y agresiva y evite su expansión. De hecho, como se indicó en el RAW preliminar, la reacción se ha estabilizado y llegó a un equilibrio. Perturbar las medidas de mitigación existentes de Chiquita pondría en riesgo que se exacerbe la reacción.[32]

Acceso y Verificación de Datos

Los datos que utiliza el Comité de la Reacción para evaluar la reacción todos los meses se encuentran todos en cada Determinación de Zona Reactiva. Por lo tanto, el DTSC ya tenía todos los datos que necesitaba para verificar los hallazgos del Comité de la Reacción. No obstante, Chiquita organizó que SCS le dé acceso al DTSC a eTools y al RMC de SCS para que el DTSC pueda ver los mismos datos crudos que utiliza el Comité de la Reacción para emitir sus hallazgos mensuales. Nuevamente, los datos que utiliza el Comité de la Reacción para sustentar sus hallazgos están todos informados en cada Determinación de Zona Reactiva, por lo tanto el acceso reciente del DTSC a los datos crudos de Chiquita no cambia la capacidad del DTSC de verificar los hallazgos del Comité de la Reacción.

El arreglo de Chiquita para el acceso del DTSC a sus datos crudos a través de eTools y RMC de SCS no tiene precedentes. Hasta donde sabe Chiquita, nunca se había organizado el acceso directo de la agencia a datos crudos de esta magnitud de partes que no son la entidad regulada y este arreglo tampoco ha sido fácil. eTools y RMC de SCS son herramientas de datos de control interno para profesionales con amplio conocimiento y pericia de vertederos y sistemas de biogás. Proporcionan operadores con experiencia y profesionales de vertederos con la capacidad de ver, cargar y analizar datos rápidamente. Para proporcionarle al DTSC acceso a estas herramientas se requirió la modificación tanto de eTools como del RMC de SCS, para que la agencia tenga acceso de solo lectura, para evitar la involuntaria modificación de datos, eliminación de archivos u otros cambios que pudieran afectar las operaciones y el cumplimiento del Vertedero.

El acceso directo de la agencia a datos crudos de Chiquita le proporciona al DTSC una cantidad de supervisión única sobre el Vertedero. Chiquita espera que otorgándole al DTSC este acceso directo, el DTSC pueda aceptar, verificar y replicar los análisis y las conclusiones de Chiquita en lo relacionado a la reacción y que Chiquita y el DTSC puedan avanzar, entendiendo mutuamente las mejores prácticas de gestión para manejar la reacción de forma efectiva.[33]

Chiquita responde a cada uno de los comentarios del DTSC y de CalRecycle a continuación.

[32] Por ejemplo, los esfuerzos iniciales de Chiquita para desplegar la cubierta de geomembrana indicada en la Orden requirió que Chiquita retirar de servicio todos los pozos de extracción de biogás y las bombas de desagote de las áreas de despliegue de cubierta activas para completar la instalación debido a que la cubierta debe instalarse debajo de las tuberías e infraestructura existentes, requiriendo la remoción de partes de la tubería para dar acceso a la instalación. (Respuesta de Chiquita Canyon, al Programa de Despliegue de Cubiertas de Geomembrana Actualizado del DTSC - Determinación de Peligro Inminente y Sustancial y Orden del DTSC sobre el Asunto del Vertedero de Chiquita Canyon, Expediente No. HSA-FY24/25-082, 7 de noviembre de 2025). Como resultado de sacar de línea todos los pozos de extracción de biogás y bombas de desagote en las áreas de despliegue de cubiertas activo, Chiquita vio un aumento en los olores en el sitio. Éste fue un factor complicado en la estrategia de despliegue de Chiquita que forzó a Chiquita a dar un giro, ya que continuar desplegando el resto de la cubierta de geomembrana utilizando el mismo modelo podría impactar negativamente el éxito de las medidas de mitigación puestos en práctica para manejar la reacción.

[33] Chiquita destaca que el "set de datos más profundo" al que se hace referencia en el RAW está completamente disponible en la determinación del Comité de la Reacción que se presentó al AQMD de la Costa Sur todos los meses y se publicó en el sitio web de Chiquita. El DTSC ya tenía acceso a este set de datos antes de obtener acceso a eTools y al RMC de SCS.

Comentarios Generales del DTSC

Chiquita responde a los comentarios generales del DTSC al principio de esta carta.

Comentarios Específicos del DTSC

1. Sección 1.0 Introducción, Párrafo 3: Esta sección trata sobre el Comité de la Reacción y el SCAQMD. El DTSC no está de acuerdo con la falta de "expansión direccional consistente" ya que las sondas de monitoreo de temperatura TP-29, TP-20 y TP-31 están muy por fuera del límite de la reacción actual hacia el borde de la cubierta superior y todas tienen temperaturas máximas que exceden los 170° Fahrenheit.

Las sondas de monitoreo de temperatura fuera de la zona reactiva con temperaturas máximas que exceden los 170° Fahrenheit no indican una expansión de la reacción. Como el DTSC reconoce en sus comentarios, la temperatura sola no es un determinante de condiciones de reacción.[34] Por ejemplo, en la determinación más reciente del Comité de la Reacción con fecha 10 de noviembre de 2025 sobre los datos de octubre de 2025, el Comité de la Reacción evaluó las temperaturas máximas de 30 días registradas en varias sondas de monitoreo de temperatura, que incluyen TP-29 y TP-31, descubriendo que las temperaturas habían quedado relativamente consistentes en el período de 6 semanas previo del 25 de septiembre al 5 de noviembre de 2025, excepto varios aumentos de un día y posteriores disminuciones en el intervalo a los 240 pies de TP-29.[35] La temperatura máxima en la termocupla que está a 240 pies de 193° Fahrenheit ocurrió solo por un día y la temperatura promedio durante el período de 30 días fue de solo 184° Fahrenheit. De todas formas, el Comité de la Reacción llegó a la conclusión de que no se justificaría un ajuste en el límite de la Zona Reactiva de la Condición 9(a) porque los dos pozos que rodean TP-29 registraron temperaturas promedio en el cabezal de biogás durante agosto a octubre de 130° Fahrenheit y concentraciones de metano promedio del 46 por ciento durante este período. Esto sugirió condiciones de descomposición normal en la subsuperficie, asociada a producción de metano. La reacción entonces no tiene una "expansión direccional consistente", ya que el Vertedero no está viendo condiciones de reacción (que incluyen más que indicadores de temperatura), consistentemente en una dirección.

Además, una revisión de los mapas de temperatura vertical máxima de treinta días proporcionado a la LEA cada mes durante el último año indica que TP-20 ha medido de forma consistente por debajo de los 141 ° Fahrenheit. No es claro por qué el DTSC cree que TP-20 ha experimentado temperaturas máximas que exceden los 170° Fahrenheit.

[34] *Consulte el* Comentario General No 4 del DTSC (“Es verdad que el solo uso de la temperatura como medición para el determinar el límite de la reacción podrá producir prejuicios...")
[35] *Consulte la* Determinación del Comité de Reacción Mensual sobre los Límites del Área de Reacción del Vertedero de Chiquita Canyon - Castaic, California, elaborada por SCS Engineers, 10 de noviembre de 2025.

2. Sección 1.0 Introducción, Párrafo 4: Esta sección indica una conclusión del Dr. Craig Benson de una declaración que se dio el 17 de julio de 2025. El DTSC requiere que se adjunte la declaración al RAW revisado para que la declaración sea considerada en cualquier análisis de RAW.

Chiquita proporciona la declaración del Dr. Craig Benson en el **Adjunto B** de esta respuesta y la anexará al RAW preliminar revisado. Chiquita aclara que la declaración se presentó el 12 de junio de 2025 y no el 17 de julio de 2025.

3. Sección 1.0 Introducción, Párrafo 5: Esta sección indica que se construyó una "barrera de suelo" entre la Celda 6 y la Celda 87A y se presentan detalles de citas de la barrera de suelo en el Informe de CQA elaborado por SCS Engineers y presentado al DTSC el 13 de mayo de 2025.

   Por los motivos indicados arriba y en nuestra carta de respuesta del 19 de mayo de 2025, el DTSC rechazó la barrera de suelo en ese Informe de CQA porque la barrera de suelo no es una medida adecuada para prevenir que la reacción en expansión ingrese a la Celda 8A y que perjudica la estabilidad de la pendiente. Además, el DTSC cuestiona la precisión y la calidad de la información presentada en los planos (en particular los Planos 2 y 3) presentados en el Informe de CQA. Por ejemplo, la Figura 2 del mismo Informe de CQA (Diseño del Sitio) muestra la vista del plano de la "superficie de la barrera de tierra" situada dentro de los Módulos 2B/3, 4 y 5 y el Cañón D, muy lejos de la vista en plano de la frontera entre la Celda 6 y la Celda 8A. Además, la sección transversal (Figura 3, "Detalles") es mínimamente informativa, no tiene líneas del proyecto transversal asociado en la Figura 2 que es una práctica estándar y no proporciona detalles confiables sobre las condiciones de la subsuperficie (es decir, límites/ubicaciones de los módulos/las celdas en la subsuperficie, como mínimo). Si los Demandados deben depender del Informe de CQA como alternativa que justifique la protección de la Celda 8A, el Informe de CQA debe revisarse para que incluya planos informativos/precisos. La incorporación del muro del Informe de CQA en cualquier barrera del RAW deberá ser evaluada en el campo, para verificar la ubicación, la extensión y la composición de la barrera de tierra existente.

Chiquita pretende confiar en el Informe de CQA como alternativa, junto con las medidas de mitigación existentes del Vertedero, justificando la protección de la Celda 8A. El consultor de Chiquita, SCS, se encuentra en el proceso de revisar el informe de CQA para tratar los comentarios del DTSC e incluir la información solicitada por el DTSC. SCS prevé finalizar el informe de CQA el 9 de enero de 2025 considerando las fiestas que están cercanas.

Sin embargo, Chiquita disputa la caracterización del DTSC del informe de CQA presentado el 13 de mayo de 2025. El informe de CQA es preciso. La información allí proporcionada describe con exactitud lo que se construyó. Definitivamente, el informe de CQA solo está previsto para resumir las actividades de construcción realizadas para instalar la barrera de tierra existente. Si la barrera de suelo existente proporcionó una medida adecuada para evitar la propagación de la reacción o no es inmaterial para la precisión del informe de CQA. Mientras que SCS puede revisar el informe de CQA para tratar los comentarios del DTSC e incluir la información solicitada por el DTSC, estas revisiones no cambiarán lo que se construyó y dónde. Por tal motivo, el informe de CQA es preciso y con una calidad estándar que resume el tipo de construcción realizada.

El rechazo del DTSC del informe de CQA se basa en la falsa idea de que la barrera de suelo existente es inadecuada porque no aísla completamente el calor del lado del suelo de la reacción para que no se propague hacia el lado del suelo donde no está la reacción. La barrera de suelo existente no necesita hacer esto.

El evento de ETLF en el Vertedero no es un resultado de desechos reactivos, como se indica arriba. Esto significa que la generación de calor no es fácilmente cuantificable y la cantidad de calor que debería aislar cualquier barrera no es calculable. Además, la barrera de tierra existente de Chiquita no está prevista para que sea un reemplazo 1 a 1 la barrera vertical solicitada. La barrera de tierra existente de Chiquita es solo una de las varias medidas de mitigación que funciona en conjunto como parte de una estrategia de gestión de la reacción mayor que cuando se evalúa en conjunto demuestra ser una estrategia de contención de la reacción efectiva.

4. <u>Sección 1.0 Introducción, Párrafo 6: Esta sección indica que la remoción de calor mediante la extracción de gases y líquidos ha "...estabilizado exitosamente la reacción". El DTSC no está de acuerdo con la declaración basada en la revisión de datos limitados disponibles para el departamento y destaca que este párrafo parece contradecir la evaluación del Dr. Benson.</u>

Chiquita reitera sus declaraciones previas de que sus medidas de mitigación han estabilizado la reacción con éxito. El DTSC tiene acceso a las determinaciones mensuales del Comité de la Reacción, que contienen importantes cantidades de datos que respaldan las conclusiones a las que se ha llegado en este informe. No es claro por qué el DTSC no está de acuerdo con la declaración que indica que la remoción de calor mediante la extracción de gases y líquidos ha "estabilizado exitosamente la reacción". El DTSC no proporciona ningún análisis o evidencia de su conclusión como parte de sus comentarios, por lo tanto es difícil que Chiquita evalúe la veracidad de la conclusión del DTSC. Al margen de esto, el DTSC ahora tiene acceso a datos crudos de Chiquita y podrá aceptar, verificar y replicar los análisis y las conclusiones de Chiquita sobre la reacción y Chiquita puede tratar cualquier pregunta de seguimiento que pueda surgir.

Tampoco es claro qué evaluaciones del Dr. Benson el DTSC cree que se contradice con las declaraciones de Chiquita. La declaración del Dr. Benson reiteradamente respalda la declaración de Chiquita que indica que la remoción de calor mediante la extracción de gases y líquidos ha "estabilizado exitosamente la reacción". (*Consulte, por ejemplo*, la Declaración de Craig H. Benson, ¶ 31 [“Los datos tomados de las sondas de monitoreo de temperatura (“TMPs”) también indican que las mejores prácticas de gestión son mantener condiciones estables dentro del vertedero”]; ¶ 36 [“Mi propia revisión de los datos térmicos que fueron tomados hasta la fecha, incluso en un período de tiempo relativamente corto en el que participé en esta evaluación, sugiere que las temperaturas en la subsuperficie que son elevadas son estables”]; ¶ 39 [“Los hechos indican que las temperaturas en la subsuperficie se han mantenido relativamente estables, que se han reducido las emisiones transportadas en el aire y que han bajado considerablemente las denuncias en respuesta a la implementación de las mejores prácticas de gestión en el Vertedero de Chiquita Canyon. Estos hechos sugieren que las mejores prácticas de gestión han sido efectivas, que el ETLF es estable y que se han reducido los impactos en la comunidad de los alrededores. La inferencia lógica de estos hechos es que deben continuar implementándose las mejores prácticas de gestión a menos que haya nueva información que indique lo contrario”]; ¶ 41 [“Los datos sugieren que las condiciones térmicas son estables y que las emisiones en el Vertedero de Chiquita Canyon se están gestionando de forma efectiva. Las mejores prácticas de gestión que se están aplicando son efectivas”].)

5. <u>Sección 1.0 Introducción, Párrafo 7, Viñetas: El DTSC proporcionar los siguientes comentarios sobre las cuatro viñetas presentadas.</u>

   - <u>Peso de la Evidencia. El DTSC agradece el trabajo del Comité de la Reacción, pero el departamento no está obligado a aceptar las conclusiones de la SOFA.</u>

- <u>Barrera de Suelo Existente. No se han demostrado al DTSC efectivamente la ubicación y la eficacia de esta barrera para evitar la migración de la reacción y por lo tanto el DTSC no puede aceptarla, ya que actúa como barrera entre la Celda 6 y la Celda 8A.</u>

- <u>Monitoreo Continuo. Lo que exhibe la sonda de monitoreo de temperatura muestra un aumento continuo de las temperaturas hacia el este y hacia el sur. Además, la falta de capacidad de compartir datos integrales hace que sea imposible que el DTSC verifique las declaraciones del CEC.</u>

- <u>Expansión Hacia el Sur. El DTSC y CalRecycle creen que la reacción se está expandiendo. El índice de expansión es imposible de discernir sin datos completos, pero ahora se puede planificar la mitigación.</u>

Como se explicó al inicio de esta carta, la temperatura no es un indicador dispositivo de que la reacción se esté expandiendo. Chiquita proporcionará una explicación actualizada en el RAW preliminar revisado, detallando la eficacia de la barrera de suelo existente como medida de mitigación, además de otras varias medidas de mitigación que se continúan implementando. Chiquita espera que los datos integrales compartidos con el DTSC respalden sus prácticas actuales y sus declaraciones previas.

6. <u>Sección 1.0 Introducción, Párrafo 8: Esta sección indica que "...el programa actual para la extracción de calor, además de la barrera de tierra que ya está puesta en práctica, parece ser efectiva para **contener** la reacción" (énfasis en "contener", agregado por el DTSC). No es claro si la barrera de suelo puesta en práctica a la que hace referencia esta sección es la misma a la que hace referencia el Informe de CQA que se encuentra entre la Celda 6 y la Celda 8A o la Celda 4 y la Celda 5. Además, se debe destacar que la Figura 1 del Apéndice D.2 muestra que la línea de la zona reactiva actual está ubicada por lo menos a 15 pies del Límite de la Zona Reactiva - Condición 9A en su ubicación más cercana y por lo menos a 850 pies del Límite de la Zona Reactiva aproximado, en base a la Revisión de Datos en su punto más cercano</u>. <u>De forma similar, la Celda 8A está ubicada a unos 700 pies del Límite de la Zona Reactiva - Condición 9A en su ubicación más cercana y a unos 1300 pies del Límite de la Zona Reactiva aproximado, en base a la Revisión de Datos en su punto más cercano</u>.

   <u>Para ser considerada una opción viable, el texto del RAW revisado debe incluir una explicación de cómo la barrera de tierra colocada está conteniendo actualmente la reacción, dado que (1) su ubicación indicada en la Figura 1 no está contigua a la zona reactiva actual, (2) no se ha demostrado que cinco pies de tierra (que no se evaluó ni se seleccionó para el escudo térmico) sea suficiente para contener la reacción y (3) parece hacer por lo menos 200 pies de desechos entre el fondo de la barrera y el revestimiento</u>.

La barrera de suelo existente a la que se hace referencia en esta sección es la misma a la que se hace referencia en el informe de CQA. Chiquita proporcionará una explicación actualizada en el RAW preliminar revisado, detallando la eficacia de la barrera de suelo existente como medida de mitigación, combinado con otras medidas de mitigación de Chiquita, que incluyen el razonamiento de su ubicación elegida, los beneficios que proporcionan las cinco pies de tierra y una aclaración de la profundidad de los desechos entre el fondo de la barrera y el revestimiento y cómo está relacionado con la barrera de suelo existente.

7. Sección 2.3.1 ETLF (Vertedero de Temperaturas Elevadas) Respuesta: Esta sección indica varias de las acciones que tomó CCL bajo varias órdenes de reguladores del gobierno, que incluyen la Orden ISE del DTSC. Debe destacarse que CCL no siguió la Orden ISE escrita explícitamente del DTSC para la reubicación del parque de tanques (Tarea 8) que indicaba que "...los tanques, ni cualquier otra estructura, pueden ser colocados en la zona cubierta al completar dicha cubierta ni ninguna zona que pueda estar sujeta al evento SET en el futuro". El Nuevo Parque de Tanques 13 se encuentra ubicado en la Celda 8B y la mayor parte del Nuevo Parque de Tanques 13 está colocada sobre los 60-80 pies de desechos, que está sujeta a expansión del evento SET. Este movimiento del parque de tanques no se hizo en "...colaboración y bajo la supervisión cercana..." del DTSC; el parque de tanques se estaba mudando antes de que se presente el RAW de la Tarea 8 al DTSC.

   Esta sección trata sobre el plan de la barrera de suelo de SCS Engineers que se presentó al DTSC en mayo de 2025 y el Informe de CQA, como también el Proyecto de Drenaje de Talud del lado Oeste. Para comenzar, la barrera de suelo que se muestra en el Informe CQA no está entre la Celda 8A y la Celda 6, sino que se encuentra sobre los Módulos 4 y 5 (como se muestra en el anexo de SCS en el mismo Informe de CQA). El proyecto de Drenaje de Talud del lado Oeste, como se indicó antes en esta carta de comentarios, es uno de los motivos por los que el DTSC está tan preocupado por la estabilidad de la pendiente global en CCL. Un evento SET no controlado genera inestabilidad de la pendiente debido a la falta de cohesión de suelo y a la fricción porosa en el prisma de desechos causada por la generación de lixiviados. A diferencia de la Pendiente Oeste, el cañón principal no tiene una barrera existente natural en la base de la pendiente para detener la falla.

   Los datos de monitoreo que muestran los niveles de líquido de lixiviados además de la pendiente oeste que indican una reducción en la producción de lixiviados, también se tratan en esta sección. El DTSC está motivado por esta reducción y cree que este tipo de colaboración de planificar también puede reflejarse en el problema de la barrera vertical.

Como el DTSC ya sabe, la posición de Chiquita desde enero de 2025 para reubicar el Parque de Tanques 9 ha sido que la Celda 8B es la única opción viable.[36] El DTSC y otras agencias solicitaron que Chiquita considere Wolcott Way; sin embargo, se determinó que esa ubicación no es viable por varios motivos. Primero, Wolcott Way es la ubicación más cercana al público. Con las inquietudes actuales sobre la mitigación del olor, Wolcott Way habría llevado al parque de tanques dentro de menos de una milla[37] del público, directamente contiguo a SR-126. También habría sido lo más visible al público. Durante las reuniones con la comunidad, miembros del público indicaron que no querían que se reubique el parque de tanques a Wolcott Way debido a los impactos visuales resultantes. Además, el Condado continuó insistiendo en que Chiquita está obligado a través del Permiso de Uso Condicional (CUP) a convertir Wolcott Way en una nueva entrada que no acomode también de forma adicional un parque de tanques. Más aún, Wolcott Way está ubicado fuera de la huella del Vertedero, implicando varios permisos adicionales que habría tenido que obtener Chiquita antes de comenzar la reubicación del Parque de Tanques 9. Dada la urgencia requerida por la Orden para la reubicación del Parque de Tanques 9, esperar que se emitan otros permisos habría puesto una pausa indefinida en los trabajos de reubicación.

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[36] *Consulte, por ejemplo,* el e-mail enviado por John Perkey a Linda Lye y a Teresa Quiaioit, con copia a varias agencias, que incluyen al DTSC, REF.: CCL - Actualización sobre el Parques de Tanques, 31 de enero de 2025.
[37] Se debe destacar que hay un desarrollo de viviendas previsto justo fuera de Wolcott Way que habría estado ubicado aproximadamente a 972 pies del parque de tanques si hubiera sido reubicado en este lugar.

Además, reubicar el Parque de Tanques 9 a Wolcott Way habría evitado que los tanques se alimenten por la gravedad, que habría requerido que se bombeen lixiviados bajo presión sobre una distancia y elevación importante. Este bombeo habría necesitado electricidad para operar. El parque de tanques además habría sido desconectado del Vertedero del Cañón Principal y habría estado más cerca del Río Santa Clara. Por último, Wolcott Way no es tan protector como la Celda 8B de incendios forestales, debido a su ubicación fuera de la línea montañosa del Vertedero. Con el aumento de incidentes de incendios forestales en 2025, esto solo fue un factor importante por el que Chiquita determinó que Wolcott Way era inviable para la reubicación del Parque de Tanques 9.

La Celda 8B es la mejor **-** y la única **-** opción viable. La Celda 8B es la menos visible y la más lejana del público. El agregado de tierra en una mayor preparación para la reubicación del parque de tanques a la Celda 8B además estabilizó el Vertedero. La Celda 8B también está ubicada dentro de la huella del Vertedero, reduciendo los permisos y las aprobaciones necesarias para proceder con la reubicación y de esta manera minimizando demoras. Estando dentro de la huella del Vertedero, la Celda 8B además proporciona una contención terciaria y es la más protectora de incendios forestales. La Celda 8B además permite que el parque de tanques se alimente por gravedad, lo que significa que se requiere un bombeo mínimo bajo presión para mover los lixiviados.

Chiquita no está de acuerdo con la caracterización errónea del DTSC que indica que "la mayor parte" del Parque de Tanques 13 está colocada sobre los 60 a 80 pies de desechos, que está sujeta a expansión del evento SET. Primero, solo una pequeña parte del parque de tanques está construida sobre los desechos de la Celda 8A. Chiquita proporciona una figura en el **Adjunto C** que exhibe la parte pequeña de la Celda 8A en la que invade el Parque de Tanques 13. Además, hay un importante relleno de tierra sobre esos desechos. La profundidad aproximada de los desechos en esta zona es de 70 a 90 pies, que minimiza el potencial de un futuro asentamiento. Análisis de la estabilidad de la pendiente llegan a la conclusión de que la reubicación del Parque de Tanques 9 a la Celda 8B no impactaría en la estabilidad de la pendiente en esta área.[38]

Todo esto se comunicó al DTSC en varias ocasiones, incluso durante una reunión celebrada el 28 de enero de 2025 y en una comunicación escrita de seguimiento del 31 de enero de 2025, cuando Chiquita compartió con todos sus reguladores, incluso el DTSC, su análisis detallado de las diferentes ubicaciones para la reubicación del Parque de Tanques 9 que se está considerando.[39] Aunque Chiquita comenzó a trabajar para prepararse para mover el parque de tanques antes de que se presentara el RAW de la Tarea 8 al DTSC, el DTSC tenía conocimiento de las actividades de Chiquita antes de su presentación.[40] Aun así, el DTSC nunca le dijo a Chiquita que debe esperar para proceder y no proporcionó comentarios sustanciales a pesar de haber tenido varias oportunidades para hacerlo durante las reuniones técnicas semanales de Chiquita y del DTSC. De hecho, el DTSC solicitó actualizaciones regulares sobre la reubicación del Parque de Tanques 9 y proporcionó información sobre el proceso de reubicación. El DTSC nunca le indicó a Chiquita que cesara la reubicación o que coloque el parque de tanques en un lugar diferente, a pesar de haber tenido varias oportunidades de hacerlo. La primera vez que el DTSC proporcionó algún tipo de comentarios sustanciales sobre la reubicación del Parque de Tanques

[38] *Consulte* arriba en la referencia anterior 3.
[39] *Consulte* arriba en la referencia anterior 8.
[40] Además de las comunicaciones previas, el DTSC y personal técnico de Chiquita se reunieron todas las semanas desde el 8 de abril de 2025 para analizar la implementación de la Orden y el desarrollo de los tres RAWs, que incluyen el RAW de la Tarea 8 y la ubicación prevista para el nuevo parque de tanques. El DTSC además sabía que Chiquita tenía previsto reubicar el parque de tanques porque el DTSC le indicó a Chiquita que lo haga en su Resumen de Violaciones (SOV) emitido a Chiquita el 1 de abril de 2025. El SOV del DTSC amenazó con imponer penalidades diarias si Chiquita no cumplía y reubicaba el parque de tanques.

9 fue muchos meses más tarde, el 29 de julio de 2025,[41] y los comentarios proporcionados nunca habían sido mencionados previamente. Aunque el RAW no fue aprobado formalmente antes de que comience la reubicación, las inquietudes sobre la salud para los humanos y el medioambiente y la viabilidad técnica tuvieron precedente en la decisión de Chiquita de proceder. Además, el Resumen de Violaciones del DTSC requirió el movimiento del Parque de Tanques 9 y evaluó las penalidades diarias hasta que se completó.

Como se trató arriba, el informe de CQA para la barrera de suelo existente es preciso. La barrera de suelo existente se construyó con el relleno de desechos de la construcción de la Celda 8A y la Celda 6. Su ubicación se exhibe con precisión. Además, análisis previos de Chiquita de la estabilidad de la pendiente no indican problemas de estabilidad global de la pendiente en el Vertedero, como se explicó antes. Sin embargo, expertos en estabilidad de la pendiente de Chiquita se encuentran en el proceso de conducir un mayor análisis para evaluar la estabilidad global de la pendiente en el Vertedero y los impactos que podían resultar si se expandiera la reacción.

Chiquita no está de acuerdo con la caracterización del DTSC del proyecto de Drenaje de Talud del lado Oeste. El motivo principal del proyecto de Drenaje de Talud del lado Oeste fue mejorar la remoción de lixiviados en esta parte del sitio. Como ya sabe el DTSC (o debería saber), reducir los niveles de lixiviados aumenta la tensión efectiva en la masa de desechos y por lo tanto mejora, en lugar de reducir, la estabilidad de la pendiente. Dado esto, es difícil comprender por qué el proyecto de Drenaje de Talud del lado Oeste está siendo citado como fuente de inquietud sobre la estabilidad global.

La declaración de que "un evento SET no controlado genera inestabilidad de la pendiente debido a la falta de cohesión de suelo y a la fricción porosa en el prisma de desechos causada por la generación de lixiviados" es excesivamente generalizada y no refleja la mecánica de la estabilidad de la pendiente de desechos. Puede ocurrir mayor generación de lixiviados y potenciales reducciones de fuerza de corte de MSW después de un evento SET, pero si estos factores contribuyen significativamente a un problema de estabilidad o no depende de múltiples variables específicas del sitio, como la geometría de la pendiente, las condiciones del drenaje, la composición de los desechos y los controles diseñados. Sugerir una relación causal automática simplifica excesivamente lo que es un análisis complejo de varios parámetros.

En este caso, la pendiente sur del cañón principal tiene una geometría sustancialmente diferente que la pendiente oeste y las dos áreas no son directamente comparables. Además, esta área del cañón principal tiene debajo una capa de recolección y extracción de lixiviados continua en todo el sistema del revestimiento de la base, que está diseñado específicamente para limitar cabezales de lixiviados elevados y los impactos asociados en la estabilidad.

Chiquita tiene el agrado de continuar analizando los factores de control reales de la estabilidad en este sitio, pero el análisis debe reflejar las condiciones diseñadas actuales y los principios geotécnicos establecidos.

Chiquita se alegra de que el DTSC encuentre alentadora la reducción en los niveles de líquido de lixiviados a lo largo de la pendiente oeste. No es claro para Chiquita, sin embargo, cómo los resultados de los datos de monitoreo representan una "colaboración en la planificación", y mucho menos que podría reflejarse en el problema de la barrera vertical. Chiquita agradecería una mayor aclaración sobre esta declaración. Por ejemplo, Chiquita estaría dispuesto a colaborar con el DTSC para determinar diferentes métricas, como activadores, en base

[41] La primera vez que Chiquita escuchó comentarios sustanciales del DTSC sobre la reubicación del parque de tanques fue en esta fecha, en el que el DTSC le proporcionó a Chiquita sus comentarios sobre el RAW preliminar del parque de tanques que Chiquita presentó el 9 de mayo de 2025.

a los niveles de lixiviados, indicando una mejora continua en la gestión de la reacción, de forma que ya no serían necesarias las alternativas exploradas indicadas en la Orden.

8. Sección 2.3.2. Determinación de la Zona Reactiva: El DTSC desea verificar y replicar los hallazgos del Comité de la Reacción y para hacerlo necesita acceso a todos los datos sin filtrar, sin seleccionar y sin editar, preferentemente a través de eTools de SCS. El DTSC también indica que el Comité de la Reacción cree que el evento SET aumentó pero no excedió el Límite de la Zona Reactiva creado por la SOFA. El DTSC y CalRecycle concuerdan en que la reacción se está expandiendo. El RAW continúa indicando que "Dado que el análisis de la Orden ISE se basa únicamente en la temperatura, no cuenta con el conjunto de datos más profundo del Comité de la Reacción, en cumplimiento con la SOFA y por lo tanto es una evaluación menos completa de la condición del Sitio". El DTSC desea tener la oportunidad de verificar y replicar los hallazgos del Comité de la Reacción; sin embargo, sin acceso a todos los datos, el DTSC no puede verificar y replicar con precisión los hallazgos del Comité de la Reacción. Por lo tanto, ante la ausencia de datos que demuestren otra cosa, la postura del DTSC y de CalRecycle (y del Comité de la Reacción) continúa siendo que la reacción se está expandiendo. Podrá haber una diferencia de opiniones en la velocidad del crecimiento de la reacción, pero el RAW y la determinación del Comité de la Reacción del 10 de junio de 2025 indican ambos que la reacción ha crecido. Además, incluso si se cree que la reacción está en equilibrio o cerca de estar en equilibrio, debe tratarse ahora la planificación de las contingencias para proteger la Celda 8A, en caso de que el evento SET amenace la estabilidad de la pendiente.

Como se indicó arriba, Chiquita está proporcionando un acceso sin precedentes a los datos crudos de Chiquita a través de eTools y el RMC de SCS. Chiquita continúa en desacuerdo con las declaraciones del DTSC y de CalRecycle que indican que la reacción se está expandiendo. Además, la caracterización del DTSC de las declaraciones realizadas en el RAW preliminar y la determinación del Comité de la Reacción del 10 de junio de 2025 son incorrectas. Ni el RAW preliminar ni esa determinación indican que la reacción ha crecido. Sino que los ajustes realizados en la línea limítrofe dirigida por datos se limitó y reflejó fluctuaciones menores típicas en las condiciones de la subsuperficie observadas en el borde de la Zona Reactiva en ese momento y respaldan la conclusión de Chiquita de que la reacción es estable. Además, no hay evidencia de que la reacción amenace la estabilidad de la pendiente. Estos problemas se tratan todos al inicio de esta carta.

9. Sección 2.4 Viabilidad de la Barrera Vertical Solicitadas, Párrafo 2: En esta sección, los Demandados declaran que desean proteger la Celda 8A. El DTSC y el Demandado están alineados en su deseo de proteger la entrada al vertedero. Si el Demandado considera que la barrera vertical no es viable, debe proponerse una opción alternativa para detener la reacción. El estado actual de la remoción de gases y lixiviados no demostró estar parando adecuadamente el crecimiento de la reacción. Como se cita arriba, el DTSC requiere que los Demandados propongan por lo menos tres alternativas de protección para que no ocurra unan falla catastrófica en la pendiente - especialmente cerca de la entrada del vertedero.

Como se explicó al inicio de esta carta y en otras varias presentaciones entregadas a reguladores de Chiquita, la barrera vertical solicitada no es viable. Las medidas de mitigación sustanciales y en curso están manejando la reacción de forma efectiva. Sin embargo, Chiquita considerará y propondrá otras alternativas a la barrera vertical solicitada.

10. Sección 2.4 Viabilidad de la Barrera Vertical Solicitadas, Párrafo 3: El DTSC comprende que habrá problemas con el control de olores y la gestión de lixiviados. Sin embargo, el evento SET

debe controlarse y no se ha demostrado adecuadamente el estado actual que indique que el Demandado esté alcanzando este objetivo.

Como reconoce el DTSC, la instalación de la barrera vertical solicitada, incluso si fuera viable, daría como resultado emisiones y problemas de manejo de los lixiviados. Como entidad regulada, Chiquita cargará el peso de una mayor aplicación de la ley por parte de sus reguladores por estas emisiones y problemas de manejo de lixiviados resultantes de la instalación de la barrera solicitada. Es poco razonable que el DTSC le ordene a Chiquita instalar la barrera vertical solicitada cuando sabe que hacerlo hará que Chiquita reciba más acciones de cumplimiento y tenga problemas de cumplimiento reglamentario.

A diferencia de lo que cree el DTSC y como se explicó al principio de esta carta en las otras varias presentaciones de Chiquita a los reguladores, las medidas de mitigación actuales de Chiquita están manejando la reacción de forma efectiva.

11. Sección 2.4 Viabilidad de la Barrera Vertical Solicitadas, Párrafo 4: El DTSC no está proponiendo construir un muro de lodo en una pendiente 2H:1V, al margen las condiciones del campo. La línea de la barrera vertical se movería para acomodar el sitio según la necesidad, mientras que el uso de calles existentes o de nuevos bancos se cortaría en las pendientes del vertedero para facilitar las plataformas de perforación en áreas planas.

Ésta es la primera instancia en la que el DTSC ha indicado que la barrera vertical solicitada se movería para acomodar el sitio según la necesidad. Mientras que Chiquita aprecia este cambio en la propuesta, no cambia el hecho de que la instalación de la barrera vertical solicitada como se describe en la Orden requiera perforaciones en las pendientes, generalmente pendientes 2:1 de hasta 150 pies de alto. Utilizar las calles existentes o construir bancos nuevos en las pendientes del Vertedero no facilitaría las plataformas de perforación, ya que no hay áreas planas viables de donde perforar que puedan soportar el peso de la maquinaria pesada requerida.

12. Sección 3.0 Diseño y Plan de Implementación, Viñetas:

- Peso de la evidencia. El Estado de California está modelando el tamaño de la reacción, en base a los datos emitidos por los Demandados. Si la zona reactiva fue modelada en 3D por algún consultor asociado al vertedero, con criterios de datos o con criterios dirigidos por datos de la SOFA, el DTSC solicita el modelado y los datos correspondientes. Conforme a los párrafos 6.11 de la Orden ISE y a la sección 78440 del Código de Salud y Seguridad, el DTSC está solicitándole al Demandado que proporcione estos datos. No proporcionar los datos será una violación de la Orden ISE y del Código de Salud y Seguridad.

- Barrera existente. Por los motivos detallados en el Comentario No. 6, el DTSC no puede verificar que la barrera de tierra esté funcionando como barrera para evitar la expansión del evento SET. Sin embargo, el DTSC está abierto a una explicación en un RAW revisado sobre qué tan bien la barrera está conteniendo la reacción.

- Monitoreo Continuo. Conforme al párrafo 6.11 de la Orden ISE y a la sección 78440 del Código de Salud y Seguridad, el DTSC solicita acceso a todos los datos tomados en el vertedero para que tenga la oportunidad de verificar y replicar este hallazgo de estabilización. Además, el SCAQMD no está de acuerdo en que los olores se estén manejando de forma eficiente. La postura del DTSC es que las emisiones continúan afectando las propiedades vecinas hasta que disminuya el aviso de violaciones del SCAQMD.

- Mitigación Inmediata. El DTSC no puede aceptar, verificar ni replicar la declaración de que no hay expansión hacia el sur de la reacción sin tener acceso a todos los datos.

Peso de la evidencia. Uno de los consultores de Chiquita modeló el tamaño de la reacción en 3D utilizando datos presentados en las Determinaciones del Comité de la Reacción como datos subyacentes para el modelado y los informes. Chiquita proporciona el modelo solicitado y los datos subyacentes en el **Adjunto D**.

Barrera existente. Chiquita proporcionará una explicación actualizada en el RAW preliminar revisado, detallando la eficacia de la barrera existente como medida de mitigación, junto con otras medidas de mitigación.

Monitoreo continuo. Como se explicó al principio de esta carta, Chiquita está proporcionando acceso sin precedentes a los datos crudos de Chiquita. Proporcionar acceso directo a los datos crudos demuestra el compromiso continuo de Chiquita en la cooperación de buena fe y de continuar siendo lo más transparente posible con sus reguladores.

Los datos crudos de Chiquita son mediciones objetivas y confiables. Por otro lado, en los avisos de violación (NOVs) del SCAQMD son indicadores subjetivos y poco confiables del tratamiento de los olores y no se basan en datos crudos. Por ejemplo, un perito de Chiquita ha determinado que aproximadamente el 20 por ciento de los reclamos de olores "verificados" del SCAQMD es poco probable que esté relacionado con el Vertedero. (Decl. de P. Sullivan, ECF 82-6, Caso No. 2:24-cv-10819-MEMF-MAR, ¶ 46.) El perito de Chiquita analizó las direcciones del viento registradas por la estación MET del Vertedero. (*Id.* en ¶¶ 44-45.) Si el denunciante estaba dentro de los 45 grados de donde estaba soplando el viento, era posible que el olor pudiera venir del Vertedero. Si la dirección del viento estaba a más de 45 grados del denunciante, se consideró que no era posible que el olor se haya originado del Vertedero. (*Id.*) Aproximadamente el 20 por ciento de las denuncias no pasó esta prueba, lo que significa que las denuncias se realizaron cuando los patrones del viento eran excesivamente poco probables de que los olores se hayan generado desde el Vertedero. (*Id.* en ¶ 46.) Hubo poca diferencia en la precisión de las denuncias "verificadas"; aproximadamente el 20 por ciento de las denuncias no pasaron la prueba de la dirección del viento o las denuncias no fueron verificadas por el SCAQMD. (*Id.*) Además, un perito estadístico revisó los datos de las denuncias del SCAQMD y descubrió que "más de la mitad de las 2,486 denuncias del AQMD que dieron como resultado un Aviso de Violación ("NOV") entre el 1 de enero de 2023 y el 23 de abril de 2025 fueron generadas por menos de 15 direcciones únicas". (Decl. de L. Marais Supl., ECF 121, Caso No. 2:24-cv-10819-MEMF-MAR, ¶ 3(c).)

Además, un comparativo entre la supervisión de olores y los datos de las denuncias comparables de principios de este año hallaron que un tercio de las denuncias analizadas fueron realizadas en un momento en el que el monitoreo de olores no descubrió ningún olor. (Decl. de P. Sullivan, ECF 82-6, Caso No. 2:24-cv-10819-MEMF-MAR, ¶ 48.) Un análisis de los datos de supervisión de la intensidad de los olores demuestra claramente que los olores se redujeron significativamente durante 2025, indicando que las medidas de mitigación de Chiquita están funcionando y son altamente efectivas en la reducción de olores en la comunidad de los alrededores. (*Consulte* Declaración de P. Sullivan de Opo. ISO a la Moción de Ej. de Mandato Prelim . 15.)

El proceso de cumplimiento del SCAQMD también es subjetivo. Los seres humanos, en general, ante la ausencia del uso de herramientas objetivas, no son buenos para determinar el origen, el carácter o el tono hedónico de un olor. (Declaración de R. Pleus de Opo. ISO a la Moción de Ej. de Mandato Prelim. en ¶ 51.) Estas insuficiencias de la nariz humana y el proceso de interpretación de olores forman la base de la investigación de los olores y de los esfuerzos de cumplimiento del SCAQMD en el Vertedero. (*Id.*) Cada paso del proceso de investigación y cumplimiento de molestias por olores suma capas adicionales de poca confiabilidad: un denunciante llama para hacer una denuncia, pero lo "verifica" un inspector del SCAQMD sin ningún equipo o dispositivo de medición. (*Id.* en ¶ 53 -56.) Este proceso de verificación de cumplimiento de los olores y de investigación del origen no utiliza una metodología respaldada científicamente, transparencia o capacidad de reproducción, algo que viola los pilares del método científico. (*Id.* en ¶ 52.) Como resultado, los datos de cumplimiento con los olores son muy susceptibles a las parcialidades de los inspectores y de los residentes al verificar los olores y rastrear su origen. (*Id.*) Ahora que el DTSC tiene acceso a datos crudos de Chiquita, Chiquita invita al DTSC a revisar su posición.

<u>Mitigación inmediata.</u> Chiquita ha trabajado con SCS para otorgarle al DTSC acceso a todos los datos crudos a través de eTools y el RMC de SCS. Chiquita tiene la esperanza de que el DTSC utilice estos datos para aceptar, verificar y replicar los análisis y las conclusiones de Chiquita en lo relacionado a la reacción.

13. <u>Sección 3.0 Diseño y Plan de Implementación, Párrafo 3: El DTSC comprende que esta sección indica que no habrá otras mitigaciones que no sean la potencial remoción adicional de lixiviados y que CCL dependerá de su barrera de tierra documentada en el Informe de CQA para mitigar la expansión de la reacción hacia la Celda 8A y la Celda 6. El DTSC les recuerda a los Demandados que la barrera vertical es requerida por la Orden ISE. Ante la ausencia de un esfuerzo de CCL de buena fe de cumplir con la Orden ISE, que incluye proporcionar datos necesarios para verificar el alcance de la reacción, el departamento podrá descubrir que CCL está fuera de cumplimiento con la Orden ISE.</u>

Chiquita comprende que la Orden requiere la instalación de la barrera vertical solicitada. Sin embargo, como se explica al principio de esta carta, Chiquita no procederá a instalar la barrera vertical solicitada porque hacerlo pondría en peligro la salud humana y el medioambiente, afectando perjudicialmente las medidas de mitigación actuales de Chiquita y además es técnicamente inviable. Por estos motivos, Chiquita no puede instalar de buena fe la barrera vertical solicitada.

Además, el RAW preliminar de Chiquita describía varias medidas que se estaban implementando para mitigar la reacción, que incluyen, de forma enunciativa más no limitativa, la remoción de lixiviados y la barrera de suelo existente. Varias de estas medidas de mitigación se trataron al principio de esta carta.[42]

Chiquita ha estado cumpliendo la Orden de buena fe y ha proporcionado los datos que el DTSC ha solicitado en todas las ocasiones. En la rara ocasión de que cumplir con la solicitud de datos del DTSC haya sido inviable, Chiquita proporcionó una explicación de su imposibilidad de proporcionar los datos. Como se analizó arriba, Chiquita ha trabajado con SCS Engineers para otorgarle al DTSC acceso a eTools y al RMC de SCS, que contiene datos crudos de Chiquita.

14. <u>Sección 3.0 Diseño y Plan de Implementación, Párrafo 4: Este párrafo del RAW vuelve a indicar que una barrera vertical es inviable y que los procesos actuales para controlar la reacción están funcionando. El DTSC y CalRecycle han llegado a la conclusión de que la reacción está creciendo.</u>

42 *Consulte* el Plan de Trabajo Preliminar de Acción de Remoción: Proteger la Celda 8A de Intrusión de Evento de Vertedero de Temperatura Elevada, elaborado por Civil & Environmental Consultants, Inc., 1 de julio de 2025, en la Sección 2.3.

Las alternativas a la barrera pueden y deben analizarse, pero debe planificarse una respuesta para proteger la Celda 8A.

Como el Comité de la Reacción ha continuado llegando a la conclusión durante los últimos varios meses y ha explicado al principio de esta carta que la reacción es estable. Sin embargo, Chiquita considerará alternativas a la barrera vertical solicitada.

15. Sección 3.1. Protección de la Celda 8A: Esta sección vuelve a indicar las acciones que buscan los Demandados en CCLA para contener la reacción, que incluye puntos que se les ordenó instalar a los Demandados, por ejemplo la nueva cubierta de EVOH HDPE de 60 milésimas de pulgada.

Chiquita está de acuerdo con esta caracterización de la Sección 3.1 del RAW preliminar. La descripción de Chiquita de las numerosas acciones que está buscando Chiquita para contener la reacción, que incluye acciones y puntos que le han ordenado instalar a Chiquita demuestra el cumplimiento de Chiquita de buena fe con la Orden.

16. Sección 3.2 Programa: La última oración indica que "si se determina que hay cambios importantes que empeoran la situación en el evento SET, la perforación comenzará apenas sea razonablemente posible, pero no deberá exceder los 90 días desde la determinación relevante del Comité de la Reacción". Sin embargo, no hay una definición en el RAW Preliminar de lo que se considera "cambios importantes que empeoren la situación" en el evento SET. Esta sección debe incluir más claridad y preferentemente estándares numéricos sobre lo que constituye "cambios importantes que empeoren la situación" en el evento SET. Además, la futura presentación del RAW Preliminar deberá incluir un Programa Maestro de todas las actividades previstas para el vertedero.

El Comité de la Reacción considera varios puntos de datos y parámetros diferentes para determinar si la reacción está experimentando cambios importantes que empeoren la situación. Todo monitoreo o medida que se tome que indique que la reacción está experimentando cambios importantes que empeoran la situación deben cumplirse durante un período sostenido; un solo punto de datos no es suficiente como para que indique una tendencia. La tabla a continuación proporciona los diferentes puntos de datos y parámetros que indicarían que la reacción está experimentando cambios importantes que empeoren la situación.[43]

Descripción de los Criterios para los Umbrales	Valor de Limitación
Temperatura	
Temperaturas de los Desecho In-Situ	230 °F
Temperatura del Pozo de LFG	190 °F
Temperatura de los Líquidos/Gases Pozo Abajo	230 °F
Temperatura de los Desechos de Perforación Removidos del Cabezal	250 °F
Composición del Gas	
Relación Metano-Dióxido de Carbono	< 0.75
Hidrógeno	> 5.0%
Metano	< 15%
Monóxido de Carbono	> 1,500 ppm

[43] Plan de Quiebre/Barrera de suelo de la Reacción, elaborado por SCS Engineers el 26 de noviembre de 2024.

Chiquita incluirá un Programa Maestro en el RAW preliminar revisado.

17. Sección 3.3. Plan de Aseguramiento de la Calidad de la Construcción: Por favor, proporcione al DTSC una copia de referencia de lo que quiere decir [*sic*] "...el procedimiento operativo estándar del Sitio", ya que esta referencia es ambigua.

La referencia de Chiquita al "procedimiento operativo estándar del Sitio" no se refiere a un documento, sin o a buenas prácticas de ingeniería y estándares de la industria que se están implementando en el sitio.

18. Sección 3.4. Permisos Requeridos: El Apéndice G indica el "Sistema de Recolección/Almacenamiento de Condensados de Biogás y Lixiviados (Permiso No. G66132, A/N 613131)". Por favor, verifique que este permiso continúa activo.

El Permiso No. G66132, A/N 613131 continúa activo.

19. Sección 3.5. Plan de Operaciones y Mantenimiento - Apéndice G: El Plan de Lixiviados adjunto está desactualizado. El RAW Preliminar revisado deberá incluir un Plan de Lixiviados que haya sido actualizado para acomodar la remoción de los Parques de Tanques 7 y 9 que fueron consolidados en el Parque de Tanques 13.

Chiquita no se encuentra en el proceso de actualizar el Plan de Gestión de Lixiviados conforme a la Orden Administrativa Unilateral de la Agencia de Protección Ambiental (EPA) de Estados Unidos emitida al Vertedero, Expediente de la EPA No. RCRA 7003-09-2024-0001 y CERCLA 106-09-2024-05 (UAO). EPA todavía no aprobó el Plan de Gestión de Lixiviados. Todavía está en forma de borrador. Dado que el Plan de Gestión de Lixiviados todavía está en forma de borrador y está siendo desarrollado bajo la UAO, Chiquita no cree que debe ser revisado mientras no tenga la aprobación de la EPA. Chiquita le proporcionará al DTSC una copia del Plan de Gestión de Lixiviados actualizado una vez que haya sido aprobado por la EPA conforme a la UAO.

Comentarios Generales de CalRecycle

Chiquita responde a los comentarios generales de CalRecycle al principio de esta carta.

Comentarios Técnicos de CalRecycle

1. CCL declara que hay instalada una barrera de tierra parcial entre las Celdas 6 y 8; sin embargo, los planos presentados indican que la barrera de tierra está ubicada en los Módulos 4 y 5. Esto demuestra que hay solo una cubierta de 5 pies sobre esta superficie y que no hay ningún muro de suelo vertical entre las Celdas 6 y 8. En base al análisis de CCL, no hay ninguna barrera interna que evite que se propague la reacción a todas las instalaciones.

Como se indicó arriba, el informe de CQA y los planos relacionados indican que la barrera de tierra existente está ubicada entre las Celdas 6 y 8. Como se explicó en el RAW preliminar, la barrera de tierra existentes, junto a las medidas de mitigación existentes del Vertedero, evitarían que la reacción se propague a la Celda 8A porque el suelo es un material inerte que no está sujeto a degradación biológica, térmica u oxidativa.

La barrera de tierra existente no está prevista para que funcione como reemplazo de la barrera vertical solicitada por sí misma. Sino que, como se explicó arriba, la barrera de tierra existente es uno de varios controles diseñados existentes, específicos del Vertedero, que en conjunto manejan la reacción de forma efectiva.

2. Esta cubierta previamente mencionada no evita que pase un Evento SET debajo de la cubierta.

Como se explicó arriba y en el RAW preliminar revisado, la barrera de suelo existente no está prevista para que funcione como reemplazo 1 a 1 de la barrera vertical solicitada por el DTSC.

3. El consultor de CCL indica que las perforaciones del suelo de la barrera de corte debería estar a más de 200 pies de profundidad y esto no es viable. Esto nuevamente es confuso, dado que los desechos en la interfaz entre las Celdas 6 y 8 están aproximadamente a 80 pies de profundidad y es realmente algo puede alcanzarse.

La barrera vertical solicitada requeriría perforaciones de aproximadamente 250 pies de profundidad. Las profundidades de las perforaciones en el lugar recomendado en la Figura 7 del Memorándum de Stark para la instalación de la barrera vertical solicitada son a 240 pies. Además, una barrera vertical "efectiva", que es inviable de construir, no puede detenerse en la marca de 80 pies de profundidad. Una barrera vertical "efectiva" requeriría más amortiguación de varias decenas de pies pasando los 80 pies, para asegurar que la reacción no pueda expandirse desde abajo, ya que la profundidad de los desechos en esta áreas es significativamente más profunda de lo que creen el DTSC y CalRecycle. Además, debido al terreno y a la topografía del lugar, debería excavarse una pendiente a través de la masa del vertedero y un respaldo a la pendiente existente para instalar la barrera vertical, incluso a una profundidad de 80 pies.

4. El CCL aclama que la US EPA "no incluye la construcción de este tipo de barrera en su lista de Potenciales Estrategias de Gestión y Mitigación para condiciones de Vertedero de Temperaturas Elevadas". El documento citado de una página no es un documento orientativo. El 16 de julio de 2025 el Dr. Max Krause de la División de Investigación y Desarrollo de US EPA dio un seminario virtual e indicó en la presentación que una de las Potenciales Acciones Correctivas es utilizar "barreras térmicas (lechada o muros verticales)".

La cita se encuentra en la página oficial de la EPA en Vertederos de Temperaturas Elevadas y es considerada una opinión del perito de la EPA sobre las estrategias apropiadas de gestión y mitigación de ETLF. Chiquita solicita que CalRecycle proporcione una copia del conjunto de diapositivas del seminario virtual al que se hace referencia, dado por el Dr. Max Krause el 16 de julio de 2025. Aun así, una barrera vertical es una potencial acción correctiva que solo debería implementarse si es viable, efectiva y segura, que lo determina un análisis específico del sitio. El análisis de Chiquita de la construcción de la barrera vertical solicitada en el Vertedero muestra en términos no poco certeros que la construcción de la barrera vertical solicitada sería inviable, impráctica y poco segura.

5. El CCL indica que es una inquietud que la construcción del muro vertical en la ubicación requerida dé como resultado otros impactos en la comunidad de los alrededores en la forma de emisiones detectables. Personal de CalRecycle comparte la misma inquietud pero se debe tener en cuenta que la intención es instalar la barrera en un área que no se vea afectada actualmente por la reacción.

La construcción de la barrera vertical solicitada requeriría que se perforen los desechos. Toda perforación en los desechos tiene el potencial de aumentar las emisiones, al margen de si la zona está afectada por la reacción o no. Además, la magnitud de la perforación requerida para instalar la barrera vertical solicitada en definitiva podría impactar en la reacción o en el éxito de las medidas de mitigación puestas en práctica para manejar la reacción utilizando otros medios, incluso si la reacción no se perfora directamente. Las inquietudes de Chiquita no son infundadas. Como se explicó en la carta de Chiquita del 7 de noviembre de 2025 enviada al DTSC respondiendo a la solicitud de la agencia de un programa de despliegue de cubierta de geomembrana actualizado, Chiquita vio impactos negativos en sus medidas de mitigación existentes durante el impulso para desplegar las 15 acres adicionales iniciales de cubierta de geomembrana en los Segmentos 1, 2 y 3 del Vertedero. Chiquita observó un aumento en las temperaturas medidas en ciertos pozos y sondas de monitoreo temperatura porque los pozos de extracción de biogás y las bombas de desagote tuvieron que retirarse de servicio para instalar la cubierta de geomembrana. Estas temperaturas volvieron a bajar apenas los pozos de extracción de biogás y las bombas de desagote de las áreas de despliegue de cubiertas activo volvieron a estar en línea.

<u>Comentarios Administrativos de CalRecycle</u>

1. <u>El RAW Final deberá ser firmado por un ingeniero profesional registrado en el Estado de California. La presentación actual es un borrador sin firmar.</u>

Chiquita está de acuerdo en que el RAW final debe ser firmado por un ingeniero profesional registrado en el Estado de California. Como la sección 5.3 de la Orden requiere que la RAW sea presentada en formato preliminar, la presentación de Chiquita del 1 de julio de 2025 se transmitió como un borrador sin firmar.

2. <u>El informe hace referencia a una nota al pie "Declaración de Craig H. Benson en Oposición a la Moción del Demandante de una Medica Cautelar Provisional, Caso No. 2:24-cv 10819-MEMF-MAR, con fecha 17 de julio de 2025"; sin embargo, no proporciona el documento al que se hace referencia, para que pueda revisarse.</u>

Como se indicó arriba, Chiquita proporciona la declaración del Dr. Craig Benson en el **Adjunto B.**

<u>Conclusión y Recomendaciones de CalRecycle</u>

Como se explicó en al principio de esta carta, es inviable, impráctico y poco seguro construir la barrera vertical solicitada. Además, no hay datos que respalden la noción de que la reacción pueda expandirse a la Celda 8A, necesitando algún tipo de construcción de barrera. La conclusión y las recomendaciones de CalRecycle reconocen esto indicando que "**<u>si</u>** debe construirse un apoyo" (con énfasis agregado) y proporcionar dos alternativas a la construcción de la barrera vertical solicitada en los subpárrafos (A) y (B). Si CalRecycle creía que debía construirse una barrera vertical para controlar la reacción, no le habría dado la oportunidad a Chiquita de tomar una acción alternativa.

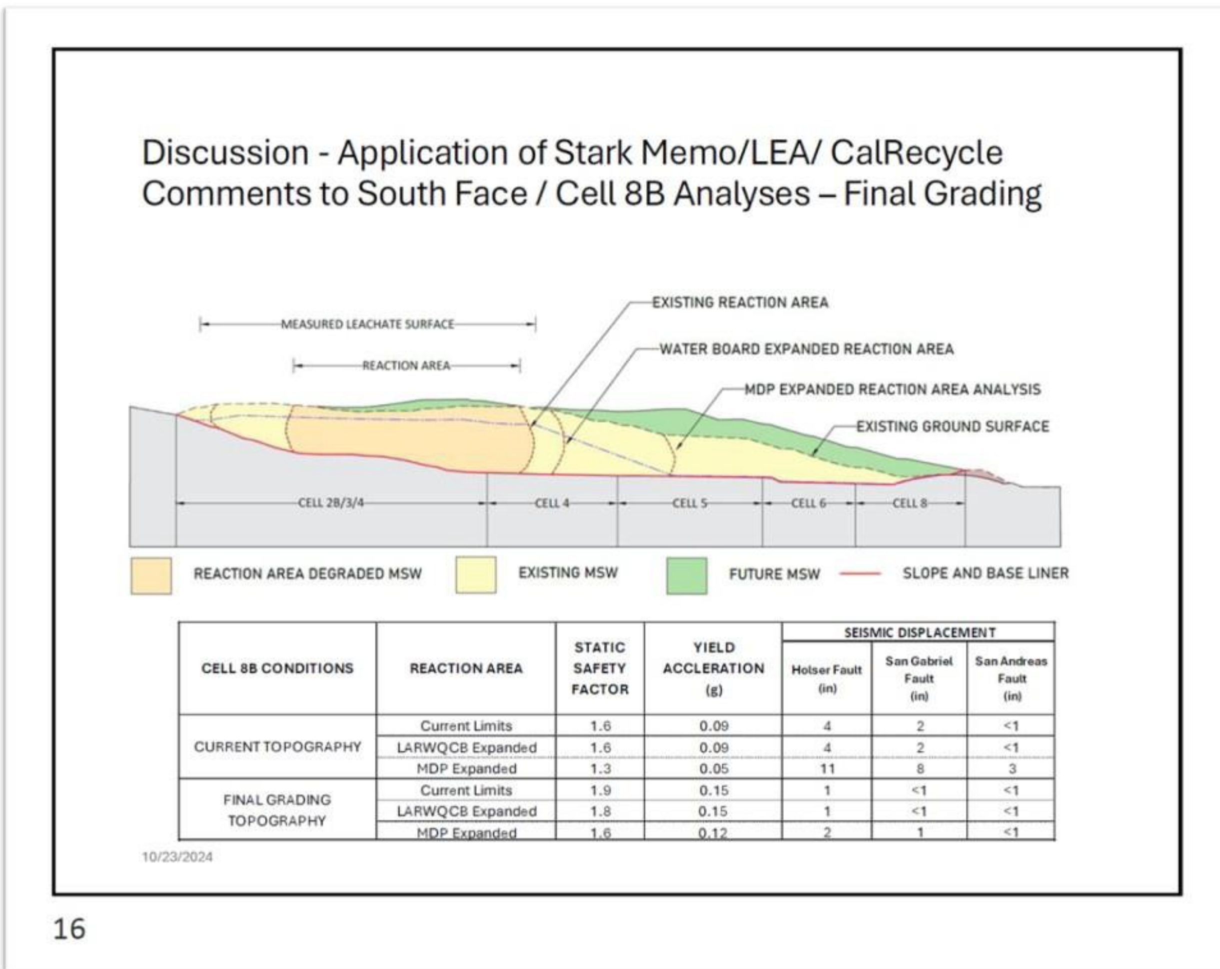
A. <u>El CCL debería completar un estudio de estabilidad integral global de la pendiente para áreas donde hay infraestructura crítica (ej. Parque de Tanques temporal 13 ubicado en la Celda 8B) asumiendo que la reacción abarca la unidad de gestión de desechos completa. El consultor de CCL, GLA, en una presentación dada a USEPA en 2024 indicó que si la reacción se expande a la interfaz del Módulo 4/5, ciertos factores de estabilidad de la pendiente comienzan a caer por debajo del factor de seguridad aceptable.</u>

Chiquita se encuentra en el proceso de completar el Plan de Trabajo de Estabilidad de la Pendiente solicitado que abarca un estudio integral de la estabilidad global de la pendiente.

Además, Chiquita y su consultor Geo-Logic Associates (GLA) disputan la declaración de CalRecycle de que GLA le hizo una declaración a la EPA en 2024 indicando que si la reacción en el Vertedero se expandía hacia la interfaz del Módulo 4/5, se verían implicados factores de seguridad inaceptables. GLA no hizo esa declaración. Es factualmente erróneo. Chiquita y GLA creen que CalRecycle en su lugar estaría haciendo referencia a una declaración diferente que hizo GLA durante una reunión celebrada el 23 de octubre de 2024. Los resultados analíticos presentados en la reunión, reproducidos a continuación, consideraron tanto la topografía actual como la topografía de la pendiente final bajo las siguientes presunciones de la zona reactiva:

1. Los límites actuales (octubre de 2024) de la zona reactiva.
2. Los límites ampliados de la zona reactiva especificados por la Junta del Agua.
3. Los límites de la zona reactiva ampliamente expandidos que se asumieron para los análisis del Plan Maestro del Desarrollo (MDP). Estos límites se extendieron aproximadamente de un tercio a la mitad del camino hacia la Celda 5 y están *__pasando la interfaz del Módulo 4/5__*.

En la situación más conservadora e hipotética, los resultados indicaron un factor de seguridad estático a corto plazo (topografía actual) de 1.3. El factor de seguridad estático aumenta a 1.6 cuando se coloca relleno en la pendiente final. Bajo estándares de práctica convencionales, factores de seguridad estáticos temporales de 1.3 generalmente son considerados aceptables, especialmente si se demuestra que el factor de seguridad aumentará con el tiempo. Además, como se describe debajo, posteriores análisis que extendían la zona reactiva a la interfaz del Módulo 4/5 indicaron factores de seguridad estáticos de 1.5 o más y deformaciones sísmicas aceptables para todas las condiciones que se analizaron.



CELL 8B CONDITIONS	REACTION AREA	STATIC SAFETY FACTOR	YIELD ACCLERATION (g)	SEISMIC DISPLACEMENT Holser Fault (in)	SEISMIC DISPLACEMENT San Gabriel Fault (in)	SEISMIC DISPLACEMENT San Andreas Fault (in)
CURRENT TOPOGRAPHY	Current Limits	1.6	0.09	4	2	<1
	LARWQCB Expanded	1.6	0.09	4	2	<1
	MDP Expanded	1.3	0.05	11	8	3
FINAL GRADING TOPOGRAPHY	Current Limits	1.9	0.15	1	<1	<1
	LARWQCB Expanded	1.8	0.15	1	<1	<1
	MDP Expanded	1.6	0.12	2	1	<1

CalRecycle aparentemente ignoró la información del informe de la carta de GLA del 9 de diciembre de 2024 "Información para Tratar los Comentarios de la Evaluación de la Estabilidad de la Pendiente Oeste y Sur de la Agencia Reguladora" que presentó los análisis utilizando considerablemente más información que los análisis que se trataron en la reunión de octubre. A continuación se muestran las secciones que se analizaron y los resultados analíticos. Estos análisis extendieron la zona reactiva al límite del Módulo 4 y el Módulo 5 y los resultados muestran factores de seguridad estáticos aceptables y desplazamientos sísmicos para todas las condiciones que se analizaron.

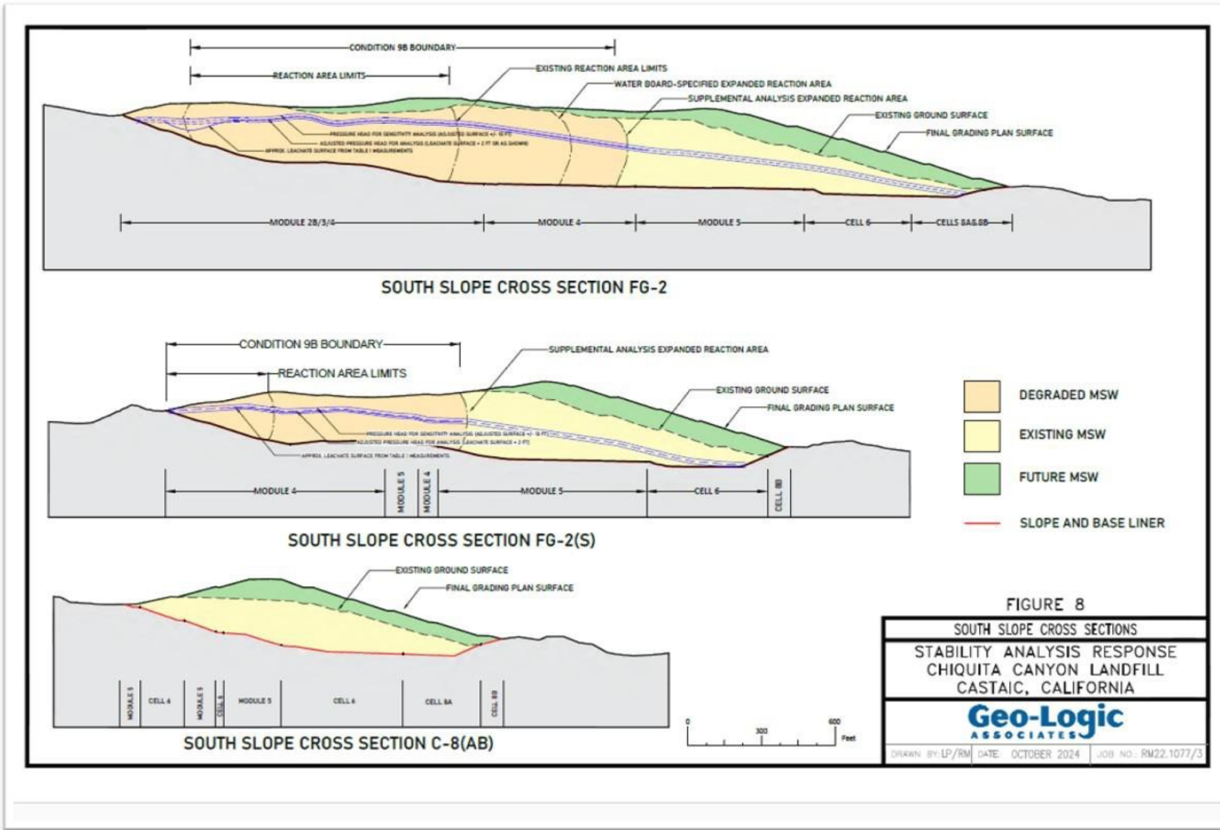


Tabla 7
RESUMEN DE LOS RESULTADOS DE LOS ANÁLISIS COMPLEMENTARIOS DE LA CELDA 8A/8B Y DE LA PENDIENTE SUR
Vertedero de Chiquita Canyon
Castaic, California

LÍMITES DE LA ZONA REACTIVA	NIVELACIÓN	FACTOR DE SEGURIDAD ESTÁTICO	DESPLAZAMIENTO SÍSMICO									
			Aceleración en el Rendimiento (g)	Falla de Holser			Falla de San Gabriel			Falla de San Andreas		
				Aceleración a 1.5T, (g)	M	Desplazamiento Estimado (pulgadas)	Aceleración a 1.5T, (g)	M	Desplazamiento Estimado (pulgadas)	Aceleración a 1.5T, (g)	M	Desplazamiento Estimado (pulgadas)
Sección FG-2 de la Pendiente Sur												
Límites Ampliados de la Reacción	Topografía Existente	1.7	0.12	0.22	6.8	2	0.20	7.3	1	0.11	8.2	<1
	Plan de Nivelación Final	1.7	0.12	0.22	6.8	2	0.20	7.3	<1	0.11	8.2	<1
Sección FG-2(S) de la Pendiente Sur												
Límites Ampliados de la Reacción	Topografía Existente	1.5	0.12	0.28	6.8	3	0.23	7.3	1	0.15	8.2	<1
	Plan de Nivelación Final	1.6	0.13	0.27	6.8	2	0.22	7.3	1	0.14	8.2	<1
Celda 8A/8B Sección AB												
No en la Zona Reactiva y Expansión a la Sección No Razonablemente Previsible	Topografía Existente	1.6	0.10	0.35	6.8	5	0.28	7.3	4	0.18	8.2	1
	Plan de Nivelación Final	1.9	0.17	0.30	6.8	1	0.25	7.3	<1	0.15	8.2	<1

B. <u>No puede ocurrir disposición de desechos activa dentro de los 500 íes de la zona reactiva definida.</u>

Chiquita no ha aceptado desechos para disposición desde el 1 de enero de 2025. El frente de trabajo de Chiquita actualmente está cerca de los 500 pies de la línea limítrofe dirigida por datos, pero Chiquita no puede garantizar que siempre estará a más de 500 pies. Este tipo de requerimiento no permitiría que Chiquita llene el Vertedero de forma que mantenga un drenaje positivo y en cambio dejaría abierto un valle que interferiría con este drenaje. No obstante, Chiquita puede comprometerse a no llenar nada más cerca que lo necesario a la línea limítrofe dirigida por datos para mantener un drenaje positivo en el Vertedero.

*****

Si tiene alguna pregunta no dude en ponerse en contacto conmigo llamando al (346) 807-5547 o escribiendo a Kate.Logan@WasteConnections.com.

Atentamente,

Kate Logan

Kate Logan
Gerente Sénior de Proyectos de Reparaciones
Vertedero de Chiquita Canyon

Adjuntos: Adjunto A - Programa Maestro Preliminar
Adjunto B - Declaración del Dr. Benson
Adjunto C - Figura que Muestra el Parque de Tanques
Adjunto D - Modelo y Datos de la Reacción

cc: Steve Cassulo, Chiquita Canyon
John Perkey, Chiquita Canyon
Dylan Smith, Chiquita Canyon
Thanne Berg, Departamento de Control de Sustancias Tóxicas
Tim Crick, Departamento de Control de Sustancias Tóxicas
Christopher Kane, Departamento de Control de Sustancias Tóxicas
Johnathon Crook, Departamento de Control de Sustancias Tóxicas
Lisa Winebarger, Departamento de Control de Sustancias Tóxicas
Bridget Floyd, Departamento de Control de Sustancias Tóxicas

ATTACHMENT A

Draft Master Schedule

The Department of Toxic Substances Control's (DTSC) October 15, 2025 letter directed Chiquita Canyon, LLC (Chiquita) to submit a draft Master Schedule.[1] Chiquita provides the requested draft Master Schedule below, which is subject to change based on actual conditions at the Chiquita Canyon Landfill (the Landfill). This draft Master Schedule focuses on the scope of DTSC's Order, including the tasks scheduled for completion pursuant to the three Removal Action Workplans (RAWs) required by the Order as well as DTSC's data requests issued pursuant to section 6.11 of the Order.

Geomembrane Cover Deployment (60-mil EVOH/HDPE)

The following primary tasks are currently being executed as part of the cover deployment process; however, as deployment continues, it is possible that efficiencies will be established that may result in changes to the timing of tasks needed to complete deployment of the geomembrane.

1. Disconnect wellheads and piping
2. Relocate gas header piping
3. Prepare subgrade
4. Deploy liner
5. Construct Access Road
6. Reconnect gas header and wells
7. Install LFG boots

As previously stated in Chiquita's November 7, 2025 response to DTSC's request for an updated cover deployment schedule, which Chiquita incorporates herein, several factors will continue to impact deployment progress, including but not limited to weather conditions through the rainy season, technical challenges, and the need to coordinate with multiple contractors, personnel, and competing and concurrent projects. Until the rainy season concludes, it is difficult to accurately project how cover deployment will progress. All dates below are approximate and subject to weather conditions.

- Deployment Schedule
  - Segments 1 and 2 – Completed September 2025
  - Segment 3 (partial) – Completed November 2025
  - Segment 3 (remaining 1.7 acres) – December 12, 2025

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[1] DTSC General Comment #1 ("The future submittal of the Draft RAW must include a Master Schedule of all activities planned for the landfill and a draft of the Master Schedule must be submitted to DTSC within seven (7) days for review. This Schedule shall also include timing of all responses to data requests."). Chiquita requested an extension to submit this draft Master Schedule as part of this response to DTSC's October 15, 2025 letter.

    - Install 16 acres of 60-mil EVOH geomembrane over the top of the existing 30-mil geomembrane cover, which involves disconnecting and reconnecting gas headers and wells, as needed, over the geomembrane cover – March 31, 2026
    - Segments 4 through 15 – November 30, 2026
    - Segments 16 through 20 – July 31, 2027 (subject to weather conditions)
- Communication and Notification Schedule for Deployment Progress
    - Provide regular updates to DTSC through:
        - Weekly technical calls (Tuesdays)
        - Written weekly updates (Fridays)
        - Bi-weekly updates regarding estimated upcoming project timelines (every other Friday)

Interim Relocation and Stabilization of Containerized Waste (Tank Farm 9)

As of November 21, 2025, Tank Farm 9 has been relocated to Cell 8B. The last primary task associated with this RAW is to obtain a grading permit from Los Angeles County Public Works (Public Works).

- Permitting Schedule
    - Submitted grading permit application – August 4, 2025
        - Received comments on grading permit application from Public Works – September 25, 2025
    - Submitted notification for Conditional Authorization of hazardous waste treatment in Tank Farm 13 to the CUPA – November 20, 2025
    - Respond to Public Works' comments on grading permit application
    - Obtain grading permit – To be determined by Public Works

Protection of Cell 8A From Intrusion of ETLF (Existing Mitigation Measures and Proposed Alternatives)

As of November 21, 2025, Chiquita has elected to consider alternatives to the requested vertical barrier in the Order. Because these alternatives have not yet been selected or finalized, Chiquita reserves the right to supplement the below schedule with additional tasks associated with the selected and finalized alternatives. The schedule below includes primary tasks associated with Chiquita's existing mitigation measures.

- Existing Mitigation Measures Schedule
    - <u>Gas Well Drilling</u>
        - Landfill gas vertical extraction well drilling will continue.
            - There are 15 additional wells to be drilled in the Tank Farm 7 area that were previously inaccessible. The drilling has already started, and there are 3 wells that have yet to be drilled.

        - Borehole logs are submitted to the South Coast Air Quality Management District (South Coast AQMD) in a monthly report pursuant to Condition 8 of the Stipulated Order for Abatement in Case No. 6177-4 (“SOFA”) (see Chiquita’s Odor Mitigation website (https://chiquitacanyon.com/odor-mitigation/) under Odor Maintenance Logs (“Stipulated Order Condition 8 (monthly reports)”).
        - Weekly well drilling updates for the drilling of landfill gas vertical extraction wells and temperature monitoring probes are submitted to South Coast AQMD pursuant to SOFA Condition 15(c) (see Chiquita’s Odor Mitigation website under Odor Maintenance Logs (“Stipulated Order Condition 15(c) (weekly well drilling updates)”).
        - Rig parts that allow for deeper drilling have been installed and the rig is now capable of drilling wells up to 195 feet in depth, subject to on-site conditions.
    - Sonic Drill Rig – TMPs and SVEs
        - The sonic drill rig finished drilling TMP-36 to TMP-40 on September 24, 2025. Chiquita ordered temperature sensors and remote telemetry heads for the drilled TMPs (TMP-36 to TMP-40). The vendor was delayed in shipment. Chiquita expects to receive the equipment by November 24, 2025, and once they arrive, Chiquita expects to install them by December 5, 2025, subject to weather conditions. The thermocouples had to be ordered after drilling was completed because the Local Enforcement Agency (LEA) directed Chiquita to use an equation that depends on the final installed TMP depth to ensure equal spacing among the thermocouples.
        - The mobilization of the drill rig and widening of the existing perimeter road to allow drill rig access required more time than initially anticipated to begin the installation of soil vapor extraction (SVE) wells. The installation of SVE well SW-3S/M was completed on October 23, 2025, and SW-3D on October 27, 2025.
        - Drilling of the remaining temperature probes (TMP-22, TMP-23, and TMP-33) is being conducted concurrently to expedite the projects to the extent feasible.
            - The sonic drill rig was redirected to complete the installation of TMP-23, while the road work continued for the SVE wells.
            - As TMP-23 was being completed, Chiquita prepared the west side road for the drilling of the SVE wells.
            - Over the upcoming weeks, the sonic drill rig will move between the SVE wells and TMPs to complete both projects.
            - TMP-23 was completed on October 22, 2025, and TMP-22 was completed on October 31, 2025.

        - Due to the current and expected rain conditions on-site, the west side road is currently inaccessible. We anticipate drilling will resume on December 1, 2025, after the Thanksgiving holiday.
    - Chiquita and the LEA held a meeting on October 17, 2025, and determined where TMP-33 should be located. This location has been staked out and the additional work required to allow the drill rig to access this location has been completed.
    - Please also see the weekly well drilling updates for the drilling of landfill gas vertical extraction wells and temperature probes submitted to South Coast AQMD pursuant to SOFA Condition 15(c) (see Chiquita's Odor Mitigation website under Odor Maintenance Logs ("Stipulated Order Condition 15(c) (weekly well drilling updates)").
    - See the weekly TMP reports submitted to the LEA pursuant to the LEA's June 6, 2024 Compliance Order and to the US EPA (see Chiquita's Odor Mitigation website under Reports, Permits, and Other Documents, LEA ("Weekly submittals of all temperature monitoring probe data in accordance with Milestone 1B")).
  - <u>Flares/TOxs</u>
    - The HERO thermal oxidizer (TOx) is now online, and the work to relocate the Parnel TOx has been completed. All three TOx are currently running.
    - The ongoing discussion with South Coast AQMD has resulted in Chiquita modifying the permit applications for the 3 gas destruction units to be classified as flares, with verbal agreement from South Coast AQMD staff on September 24, 2025, supporting the ongoing operation of the 3 units until Flares 4 and 5 are online. Chiquita submitted an application for a permit to construct/operate and a Title V permit modification for Flare 4 to South Coast AQMD on October 30, 2023. This flare will provide additional critical destruction capacity once installed. Under the current SOFA, Chiquita would need to take down Flare 1 once Flare 4 is permitted and operational.
    - Chiquita is working through problems with the Los Angeles County Electronic Permitting & Inspections (EPIC LA) system regarding the review and approval of grading permits for Flare 4.

Data Requests (Order Section 6.11)

As of November 21, 2025, Chiquita has provided DTSC with access to data pursuant to Order section 6.11 on the following dates. Several of these documents were previously submitted to DTSC and other regulators.

- Soil compaction results for the soil placed in Cell 8B – May 7, 2025
- Follow up summary of soil compaction results – June 3, 2025

- AutoCAD files for the January 2023 topographic map and subgrade map – June 12, 2025
- Surface and base elevations for TMP-21 through TMP-35 – July 2025
- Proposed data delivery schedule pursuant to Order section 6.11 – July 21, 2025
- Raw gas data collected for the Landfill from August 20, 2024 to August 20, 2025 – August 25, 2025
- Topography of the surface of the Landfill in AutoCAD format for August 2025, ground survey points to fix the 2025 topography and properly orient the AutoCAD data, and boring logs for TMP-01 through TMP-21 and TMP-24 through TMP-35 – September 8, 2025
- EVOH Construction Quality Assurance documents – September 25, 2025
- Spreadsheet with latitudes and longitudes for a specific list of wells – October 14, 2025
- Data Management Plan – October 21, 2025 (originally submitted to US EPA and the RMAC in July 2024)
- Raw data via SCS eTools – October 30, 2025
- Raw data via RMC – November 3, 2025

ATTACHMENT B

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Attorneys for Defendants Chiquita Canyon, LLC, Chiquita Canyon, Inc. and Waste Connections US, Inc.

UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA, WESTERN DIVISION

THE PEOPLE OF THE STATE OF CALIFORNIA, by and through Dawyn R. Harrison, County Counsel for the County of Los Angeles, and THE COUNTY OF LOS ANGELES,

Plaintiffs,

vs.

CHIQUITA CANYON, LLC, a Delaware limited liability company; CHIQUITA CANYON, INC., a Delaware corporation; and WASTE CONNECTIONS US, INC., a Delaware corporation,

Defendants.

CASE NO. 2:24-cv-10819-MEMF-MAR

DECLARATION OF CRAIG H. BENSON, PHD, PE, BCGE, BCEE, NAE

Filed Concurrently with Opposition to Motion for Preliminary Injunction

Date: July 17, 2025
Time: 10:00 a.m.

Assigned to Hon. Maame Ewusi-Mensah Frimpong, Courtroom 8B

DECLARATION OF CRAIG H. BENSON, PhD, PE, BCGE, BCEE, NAE

I, Craig H. Benson, PhD, PE, BCGE, BCEE, NAE, declare:

1. I have been engaged by Defendants' Chiquita Canyon, LLC, Chiquita Canyon, Inc., and Waste Connections US, Inc. (collectively, "Chiquita Defendants") to provide expertise regarding the Chiquita Canyon Landfill (the "Landfill"), in support of Defendants' opposition to Plaintiffs' Motion for Preliminary Injunction in the above-captioned action. This Declaration sets forth my professional opinions regarding the Chiquita Canyon Landfill's ongoing Elevated Temperature Landfill ("ETLF") event. My opinions in this Declaration are based on industry standards and are stated to a reasonable degree of scientific and engineering certainty. If called as a witness, I could and would testify competently to the material facts and opinions herein.

2. This Declaration is based on my assessments to date, which were conducted over a limited time frame. With additional time, I could have and would have done additional analysis. My opinions could change with additional information and analysis. I reserve the right to update my opinions should additional information become available.

3. I hold the titles of Wisconsin Distinguished Professor Emeritus at the University of Wisconsin-Madison and Dean of Engineering Emeritus at the University of Virginia. I have a PhD in engineering with a focus on landfills and waste containment, and nearly 40 years of experience in engineering research and practice related to municipal solid waste ("MSW") landfills and solid waste containment systems as a Wisconsin Distinguished Professor Emeritus at the University of Wisconsin-Madison and as Dean of Engineering Emeritus at the University of Virginia. I am a board-certified environmental engineer by the American Academy of Environmental Engineering and Scientists ("AAEES") and board-certified geotechnical engineer by the Geo-Institute of the American Society

of Civil Engineers. I am an elected member of the US National Academy of Engineering ("NAE") and am past-Chair of NAE Section 4 on Civil and Environmental Engineering.

4. I have extensive experience working on landfills and waste containment systems for a diversity of waste streams at locations throughout the United States, Canada, South America, Europe, Africa, Japan, Australia, and New Zealand. This experience has provided me with a broad and detailed knowledge of operational and design issues for landfills and other waste containment systems.

5. I served as a co-Principal Investigator on an expert team of engineers charged by the Environmental Research and Education Foundation ("EREF") to develop an understanding of MSW landfills with elevated temperatures that persist over large areas, which are referred to as ETLFs. This expert team, referred to as the EREF ETLF team, was charged with understanding causative mechanisms for the persistent high temperatures at ETLFs, identifying strategies to prevent ETLFs, and recommending best management practices for ETLFs.

6. I have been engaged in evaluating many of the major ETLFs over the past two decades, including those at Countywide Landfill, Congress Landfill, Waimanalo Gulch Landfill, Bridgeton Landfill, Middle Point Landfill, and Bristol Landfill. I am currently engaged as the expert engineer for the Bristol Landfill in Bristol, Virginia, providing oversight, review, and recommendations associated with managing the Bristol ETLF. I am also engaged as an engineering expert evaluating conditions and practices at the Middle Point Landfill ETLF in Murfreesboro, Tennessee. I have published referred research papers regarding mechanisms contributing to heat accumulation in ETLFs, thermal properties of MSW affecting heat transfer in ETLFs, pyrolytic reactions in ETLFs, and temperature-dependent compression and settlement of MSW. Causative mechanisms and best management practices to address ETLFs was one of the

lecture themes for my 2024 Kappe Lecture series tour for the American Association of Environmental Engineers and Scientists.

7. My education, training, professional background, and expertise are summarized in my curriculum vitae, attached as **Exhibit A**.

8. I have been engaged as an expert by a broad range of private sector and public sector entities. My public sector engagements include the US Environmental Protection Agency, US Department of Energy, US Nuclear Regulatory Commission, US Department of Defense, Wisconsin Department of Natural Resources, Iowa Department of Natural Resources, Missouri Department of Natural Resources, Tennessee Department of Environmental Conversation, Michigan Department of Environmental Quality, Idaho Department of Environmental Quality, Utah Department of Environmental Quality, Texas Commission on Environmental Quality, Montana Department of Environmental Quality, Wyoming Department of Environmental Quality, and the Virginia Department of Environmental Quality. My private sector engagements include Republic Services Inc., Waste Management Inc., GFL Inc., Cleveland-Cliffs Inc., Bayer Corporation, Simplot Corporation, Morrow Energy, Evergy Inc., Energy Fuels Resources Inc., Alcoa, and the Electric Power Research Institute.

<u>Background on Elevated Temperature Landfills</u>

9. Landfills are highly engineered containment facilities for solid wastes that include engineered barriers and control systems for managing liquids and gases associated with the waste with the objective of protecting groundwater and air. Modern MSW landfills include engineered liners beneath the waste that retain leachate (contaminated water released from the waste) and engineered covers above the waste to control the ingress of precipitation and egress of gases.

Leachate collection and treatment systems are used to collect the leachate contained on the liner surface, followed by treatment to remove contaminants prior to discharge. Typically, leachate treatment occurs offsite. Gas collection and control systems ("GCCS") are used to collect gas emitted from the waste and to treat the gas so that it can be discharged to the atmosphere.

10. A portion of the organic fraction of MSW placed in a landfill undergoes microbial decomposition. This process produces landfill gas ("LFG"), which is comprised primarily of methane and carbon dioxide under typical conditions along with much smaller fractions of other constituents. Under normal conditions, LFG is collected and treated by the GCCS prior to discharge. In some cases, the treatment system may include combustion or conversion of the methane to produce renewable energy. The microbial decomposition process also produces heat, which results in the waste mass temperature being above ambient atmospheric temperatures. Under normal conditions, heat does not accumulate to a level at which the biological process is inhibited.

11. Water is present in waste due to the ingress of precipitation after disposal in the landfill and wetting that may have occurred prior to disposal. Water in contact with waste solids and gases is referred to as leachate. Leachate contains a variety of inorganic and organic constituents that have the potential to impact groundwater and other water resources, and therefore is collected for treatment. Leachate drains by gravity to the bottom of the landfill, where the liner redirects flow laterally to a sump. Leachate in the sump is removed by a pump. In some cases, when drainage within the waste is constrained, vertical extraction wells with pumps are installed in the waste to remove leachate. The wells generally are also used to collect LFG, and are referred to as dual-phase extraction wells, with the two phases being leachate and LFG.

12. The EREF ELTF research team defined ETLFs as MSW landfills with gas wellhead temperatures substantially in excess of 65 ^{o}C (150 ^{o}F) that persist over a large area for a sustained period of time. This definition has been broadly adopted by practitioners and environmental regulators throughout the United States. The elevated temperatures have a variety of impacts, including alterations in gas composition, higher rates of settlement, alterations in leachate chemistry, and generation of odors. ELTFs differ from MSW landfills with a limited number of wells operating under a higher operating value (HOV) exemption, which are landfill gas wells permitted to operate at a temperature in excess of 55 ^{o}C (131 ^{o}F). An informal survey I conducted indicated that approximately one-third of the MSW landfills in the United States have at least one gas well operating under an HOV exemption.

13. ETLFs are uncommon. The first ETLF occurred circa 2006. Since then, approximately ten to 15 ETLFs have been recognized. Some of these are described in a fact sheet issued by the US Environmental Protection Agency ("USEPA")[1].

14. ETLFs occur when exothermic, or heat-releasing, processes within the waste mass generate heat at a rate that is faster than the rate at which the heat can dissipate into the surrounding environment. Consequently, the heat accumulates in the waste, resulting in increasing temperatures. The heat spreads and waste temperatures increase until an equilibrium is reached between the rate of heat generation and the rate heat dissipation.

15. Exothermic reactions are the source of heat in ETLFs. These reactions are known at some ETLFs, such as the exothermic reactions associated with

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[1] USEPA, When Does a Municipal Solid Waste Landfill Become an Elevated Temperature Landfill (ETLF)? (Jan. 2022), https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=CESER&dirEntryId=354569.

aluminum metal in aluminum processing wastes at the Countywide Landfill in Sparta, Ohio and the Middle Point Landfill in Murfreesboro, Tennessee. At other landfills, such as the Congress Landfill in Chicago, Illinois or and the Bristol Landfill in Bristol, Virgina, the exothermic reactions have not been identified conclusively. The exothermic reactions responsible for ETLFs are generally believed to be abiotic (non-biological in origin) with origins in hydration and carbonation of reactive surfaces in the waste (e.g., some coal combustion and incinerator ashes can have reactive surfaces) and potentially exothermic pyrolysis.

16. Very wet or saturated waste and high leachate levels are common in ETLFs, precluding combustion reactions (smoldering combustion, fire) as significant sources of heat. Consequently, the mechanisms causing ETLFs generally are different from landfill fires or smoldering combustion, which are more common near the landfill surface where oxygen is available. Combustion generates charred waste, combustion odors, and gas laden with particulate (smoke), each of which is not common at ETLFs. Strategies to address heat in ETLFs necessarily are very different from those used to manage combustion in MSW.

17. ETLFs typically have several common characteristics in addition to the elevated waste and landfill gas temperatures. These include (1) landfill gas composition that differs from that of gas released from conventional microbial decomposition processes in MSW; (2) elevated leachate generation rates; (3) elevated concentrations of inorganic and organic constituents and suspended solids in the leachate; and (4) higher rates of compression of the MSW.

18. The elevated temperatures in ETLFs suppress the methanogenic microbial community in MSW associated with decomposing the organic matter in MSW under typical MSW landfill conditions. Consequently, the LFG in ETLFs generally has lower methane content and higher carbon dioxide content compared

to LFG in a landfill operating under conventional conditions with methanogenic microbial decomposition.

19. LFG in ETLFs often contains reduced sulfide compounds that are highly odiferous, even at low concentrations. Consequently, LFG from ETLFs has a distinct pungent odor that is different from conventional LFG. Dimethyl sulfide (DMS) is one of the most common of these odiferous reduced sulfide compounds in LFG at ELTFs.

20. The elevated temperatures in an ETLF soften the solid components in MSW, reducing the stiffness of the solid matrix in MSW, resulting in increased magnitude and rate of settlement. The softening of the solid matrix also results in the release of moisture that is typically bound within the pores of the waste. This release of moisture is responsible for much of the higher leachate generation rates associated with ETLFs.

21. The elevated temperatures and the absence of oxygen in MSW in an ETLF may result in pyrolysis, which is defined as the thermal decomposition of organic matter in the absence of oxygen. The pyrolytic decomposition process results in the release of constituents from the solids to the leachate, a factor responsible for the elevated concentrations of organic constituents in leachate at ETLFs. These organic constituents often include acetone, benzene, toluene, and ketones. Pyrolysis in ETLFs generally is endothermic, meaning that the decomposition process consumes energy. However, pyrolysis can be exothermic (energy and heat releasing) under certain pressure and energy conditions. The role of exothermic pyrolysis in ETLFs is a topic of current research.

22. A crock pot is a useful analog to an ETLF. A crock pot is filled with organic solid matter (meats, vegetables, etc.), with the pore spaces between the solids filled with liquid (broth). When the crock pot is first filled, the solids are relatively firm and rigid, and the pore water between the solids is dilute. A lid is

placed on the upper surface, constraining the release of heat and moisture. Heat is applied to the contents in the pot. This heat for cooking softens the solid matter, which releases substances to the broth. The process also releases an aroma. After a period of sustained heat application, the solid matrix is soft and compressible, and the liquid phase is highly concentrated. These analogous processes occur in the MSW within an ETLF.

Chiquita has Followed Best Management and Control Practices for Elevated Temperature Landfills

23. Even with aggressive actions, dissipation of heat within an ETLF occurs slowly. Noticeable reductions in waste temperature often do not occur for several years after heat removal has been initiated. For example, experience at the Congress Landfill in Illinois has shown that a decade or more is required to dissipate the heat accumulated in an ETLF. Best management practices developed based on findings and recommendations from the EREF ETLF team along with industry experience recognize these limitations, and focus on practical outcomes that minimize impacts while removing heat.

24. Heat is released from an ETLF by thermal diffusion into the surroundings and by convection through the removal of LFG and leachate. Thermal diffusion into the surroundings is a slow heat transfer process controlled by thermal conductivity of the MSW and the surroundings. Convection is a more rapid heat removal process, where the heat contained within the MSW is physically extracted when leachate and gas are removed. The heat capacity of liquid is much greater than that of gas. Therefore, aggressive leachate removal is a best management practice and is regarded as the most effective and practical heat removal strategy in ETLFs.

25. ETLFs tend to be very wet or saturated, with high leachate levels. Vertical dual-phase extraction wells are often installed in ETLFs to concurrently remove leachate and gas from the waste mass. These wells remove heat that has accumulated in the waste, and also drain liquid-filled pore spaces. Drainage of the pores enhances the gas permeability of the MSW, resulting in more effective removal of gas and management of odors. Thus, best management practices for ETLFs include deployment of a dense network of dual-phase gas collection wells that remove both leachate and gas. The aggressive gas removal via these wells also reduces impacts by reducing odiferous emissions provided that there is an effective gas treatment system.

26. Other best management practices that address emissions include application of interim cover to control surface emissions and installation of seals around gas well penetrations. Interim cover using a geomembrane has been found to be very effective, including but not limited to EVOH geomembranes that have very low gaseous diffusion coefficient. Perimeter misting systems can also be applied to treat odiferous gases that could not be captured for treatment, and odor and gas surveillance systems can be installed to detect odors and monitor the concentrations of constituents released into the atmosphere.

27. State regulators have mandated that Chiquita Canyon Landfill implement numerous mitigation measures including installing cover to contain surface emissions and additional dual-phase extraction wells. These actions have been undertaken, as described subsequently.

28. As detailed in the Declaration of Steve Cassulo, Chiquita Canyon Landfill has implemented these best management practices. Since 2023, 292 additional vertical gas wells have been placed that have the capacity for dual-phase extraction, and 170 leachate pumps have been installed in the vertical extraction wells. Cassulo Decl. ¶¶ 16, 34. More pumps are planned for deployment. *Id.* ¶ 34.

Geomembrane has been installed over approximately 46 acres, with an additional geomembrane installation scheduled. *Id.* ¶ 21. A perimeter misting system has been deployed to address odoriferous emissions, odor monitoring is being conducted routinely, drone surveillance has been deployed to monitor for surface emissions, and air monitoring stations have been installed on-site and within the community. *Id*. ¶¶ 48, 51. The monitoring stations include on-location gas chromatography to provide real-time assessment of volatile organic compounds in the atmosphere. *Id*. ¶ 50. Chiquita Canyon Landfill has also installed two thermal oxidizers and one additional flare to treat the gas being extracted. *Id*. ¶¶ 19, 20.

By Following Established Guidance, Chiquita is Succeeding in Mitigating the ETLF's Effects

29. The Declarations of Steve Cassulo and Patrick Sullivan, who is an air quality and LFG systems specialist and Senior Vice President with SCS Engineers, Inc., demonstrate that these practices have had significant impact. Gas extraction at Chiquita Canyon Landfill has nearly doubled since 2023, leachate extraction has increased considerably, with more than 7 million gallons extracted in April 2025 alone, surface exceedances measured by drone have been reduced, sulfide concentrations in the atmosphere have declined steadily, and odor surveillance has shown that the frequency of objectionable odor (defined as an odor index >3+) present in the Landfill surroundings has dropped substantially. *See* Cassulo Decl. ¶ 39; Sullivan Decl. ¶¶ 20, 32, 40 and exhibits.

30. Frequency of odor complaints, while subjective, can be an indicator of the effectiveness of best management practices at ETLFs. The monthly complaint record for 2023, 2024, and 2025 is included in the Sullivan Declaration (Ex. 20)

and shows that odor complaints declined by more than a factor of three since the best management practices were implemented.

31. Data collected from the temperature monitoring probes ("TMPs") also indicate that the best management practices are maintaining stable conditions within the landfill. I have reviewed the temperature profiles from the TMPs, and they indicate that temperatures have changed little on a year-on-year basis. Three TMPs have shown larger increases in temperature year-on-year (TMP-8, TMP-11, and TMP-13), but even in these TMPs, the temperatures remain modest and considerably lower than observed at many other ETLFs.

<u>Todd Thalhamer's Report and the County Declarants' Conclusions are Scientifically Unsound and Deviate from Best Practices</u>

32. Mr. Thalhamer has provided an assessment of the Chiquita Canyon Landfill ETLF in a letter to Ms. Karen Gork of the Los Angeles County Department of Public Health dated 28 March 2025. He refers to the condition at Chiquita Canyon Landfill as a subsurface elevated temperature ("SET") event. The SET nomenclature is used by Mr. Thalhamer and one of his collaborators to describe ETLFs, but is not a broadly accepted term in industry, regulatory, or academic environments.

33. Mr. Thalhamer correctly recognizes that a portion of Chiquita Canyon Landfill is an ETLF, with persistent elevated temperatures monitored within the waste and at gas well heads, gas composition consistent with ETLF conditions, and accelerated waste settlements due to elevated temperatures. This recognition is consistent with my review of the data and site conditions.

34. My review of Mr. Thalhammer's report indicates that he has not identified the mechanisms responsible for the elevated temperatures using the

accepted scientific method, which includes hypothesis formulation and evaluation using data and other factors. In the short period in which I have been engaged in this assessment, I have not had the opportunity to evaluate and identify the mechanisms responsible for elevated temperatures. ETLFs are very complex, and understanding the causative mechanisms requires detailed study over a considerable period. Even with a high level of effort, the causative mechanisms frequently are not identified. To my knowledge, no one has drawn firm and defensible conclusions regarding causation of the ETLF at Chiquita Canyon Landfill.

35. Mr. Thalhammer has inferred that separate areas of heat generation are evolving within the ETLF in response to gas collection system operations. I found no scientific basis for these inferences based on the information contained in his report.

36. Mr. Thalhamer has concluded that the "reaction area is expanding" and that the "containment strategy has failed." I found no convincing scientific evidence in his report to support this conclusion. My own review of the thermal data that has been collected to date, albeit over the relatively short period in which I have been engaged in this assessment, suggests that the subsurface temperatures that are elevated are stable.

37. I found no evidence that the area comprising the ETLF is expanding or that a process is underway that would accelerate expansion. A local equilibrium appears to exist that precludes expansion of the area comprising the ETLF.

38. Mr. Thalhamer has concluded that a "soil barrier" must be installed to provide a "thermal block" to prevent expansion of the ETLF. No rational basis for this recommendation is provided and no engineering analysis or design is used to illustrate how this barrier will provide a "thermal block." My own assessment, albeit in the limited period for which I have had to study the issue, suggest that

using a soil barrier as a "thermal block" is illogical, inconsistent with thermodynamic principles, and potentially could exacerbate subsurface conditions, emissions, and impacts on the surrounding community. Installation of the soil barrier based on the current logic would be contrary to best management practices from my assessment.

39. The facts show that subsurface temperatures have remained relatively stable, airborne emissions have diminished, and complaints have dropped considerably in response to implementation of best management practices at Chiquita Canyon Landfill. These facts suggest that the best management practices have been effective, the ETLF is stable, and impacts on the surrounding community have been reduced. The logical inference from these facts is that the best management practices should continue to be implemented unless new information to the contrary becomes available.

Conclusion

40. Chiquita Canyon Landfill is applying the best management and control practices to address the ETLF consistent with site-specific conditions. These practices have been highly successful at other ETLFs and are expected to be successful at Chiquita Canyon Landfill.

41. The data suggest that the thermal conditions are stable, and that emissions at Chiquita Canyon Landfill are being managed effectively. The best management practices that are being applied are effective.

42. Experience from other ETLFs suggests that application of these best management practices at Chiquita Canyon Landfill will continue to be successful in controlling the impacts, and that the ETLF conditions will diminish over time provided these best management practices are continued.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed on this 12th day of June 2025 in the Town of Middleton, Wisconsin.

Craig H. Benson, PhD, PE, BCGE, BCEE, NAE

Exhibit 1

CRAIG H. BENSON, PHD, PE, BCGE, BCEE, NAE

Wisconsin Distinguished Professor Emeritus, University of Wisconsin-Madison
Dean of Engineering Emeritus, University of Virginia

3299 Saracen Way, Verona, Wisconsin, 53593 USA
Phone: +1 (608) 444-0007
Email: chbenson@chbenson.org

EDUCATION

BSCE, Lehigh University - 1985
MSE, University of Texas at Austin – 1987 (Civil Engineering, Geotechnical/Geoenvironmental)
PhD, University of Texas at Austin – 1989 (Civil Engineering, Geotechnical/Geoenvironmental)

REGISTRATION AND APPOINTMENTS

US National Academy of Engineering, Inducted 2012
US National Academy of Inventors, Inducted 2018
American Association for Advancement of Science, Fellow, Inducted 2019
Professional Engineer, State of Wisconsin, License No. 34108-006
Board Certified Environmental Engineer, American Society of Environ. Engrs. & Scientists
Board Certified Geotechnical Engineer, Geo-Institute of the American Society of Civil Engineers

ACADEMIC LEADERSHIP APPOINTMENTS

Dean, School of Engineering, University of Virginia, Charlottesville, Virginia, July 2015 – June 2021 (Reappointed June 2020, Retired July 2021, Emeritus December 2022).

Director of Sustainability Research and Education and Co-Director of the Office of Sustainability, University of Wisconsin, Madison, Wisconsin, 2011-2015.

Chair, Civil & Environmental Engineering, University of Wisconsin, Madison, Wisconsin, 2011-2015.

Chair, Geological Engineering, University of Wisconsin, Madison, Wisconsin, 2007-2015.

Chair, Civil & Environmental Engineering, University of Washington, Seattle, WA, 2008-August 2009.

Director, Recycled Materials Resource Center, University of Wisconsin, Madison, Wisconsin, 2007-2011. ⓘ

Director, Wisconsin Geotechnics Laboratory, University of Wisconsin, Madison, Wisconsin, 2000-2015.

Management Board, Consortium for Risk Evaluation and Stakeholder Participation, US Department of Energy, 2009-present. ⓘ

Associate Chair for Environmental Science and Engineering, Dept. of Civil & Environmental Engineering, University of Wisconsin, Madison, Wisconsin, 2004-2007.

Co-Director, Consortium for Fly Ash Use in Geotechnical Engineering, University of Wisconsin-Madison, Co-Director, 1999-2007.

PROFESSIONAL AND COMMUNITY LEADERSHIP APPOINTMENTS

Roundtable Linking Defense Basic Research to Leading Academia Research and Engineering Communities, National Academy of Engineering and US Department of Defense, 2019-2021.
Board of Trustees, Lehigh University, Bethlehem, Pennsylvania, 2018-2021.
Engineering Advisory Board, Lehigh University, Bethlehem, Pennsylvania, 2018-2020.
Sustainability Advisory Panel, ExxonMobil Corporation, Irving, Texas, 2017-2023 (disbanded).
National Academy of Engineering, Washington, DC.
Committee on Awards (2019-2022, Vice Chair 2020–2021, Chair 2021-2022)
Section 4, Chair (2021 – 2023), Vice Chair (2019 – 2021), Secretary (2016 – 2018), Nomination Committee (Chair, 2016 – 2018)
Committee on Grand Challenges and Opportunities in Environmental Engineering and Science for the 21st Century (2017-1018).
Board of Directors, Commonwealth Center for Advanced Manufacturing, Disputanta, Virginia, 2015-2021, Chair (2018-2021), Vice Chair (2016–2018), Executive Committee (2015–2021), Compensation Committee (2018-2021), Governance Committee (Chair, 2016–2018; Vice Chair, 2018-2021).
Advisory Board, Global Waste Research Institute, California Polytechnic Institute at San Louis Obispo, 2010-present.
Board of Directors, Sustain Dane, Madison, Wisconsin, 2014-2015.
Geo Institute of ASCE, Board of Governors, Board Member 2007-2014, Treasurer 2010-11, Vice President 2011-12, President, 2012-13.
Editor-in-Chief, *Journal of Geotechnical and Geoenvironmental Engineering*, 2004-06.
Executive Committee, Committee D18 on Soil & Rock, ASTM International, 2006-2013, Liaison to Geo Institute Board of Governors, 2007-2011, Vice Chair, 2011-2013.
Glacier's End Homeowners Association, Town of Middleton, WI, President, 2012-2015, Vice President, 2010 – 2012, 2020-present.
Independent Technical Review Committee for On-Site Disposal Facilities, US Department of Energy, Appointed by Asst. Secretary J. Rispoli, Chair 2007-2010 (disbanded).
Park Commission, Town of Middleton, Wisconsin, Commissioner, 2010-12.
Research Council, Environmental Research and Education Foundation, 2011-present, Vice Chair 2016-2017, Chair 2017-2018.

INDUSTRY EXPERIENCE

Dr. Benson has been extensively engaged by the environmental, energy, mining, and manufacturing industries over the last 30+ years. His recent roles include specialty engineering consultant, strategy advisor, leadership advisor, expert witness in litigation support, and corporate board director/chair. Dr. Benson's industry experience spans six continents and more than 100 companies. More information on Dr. Benson's industry experience can be provided on request.

FACULTY APPOINTMENTS

Hamilton Endowed Chair in Engineering, University of Virginia, 2015-2022 (Emeritus Dec. 2022).
Honorary Professor, Southwest Jiaotong University, Chengdu, China, 2017.
Adjunct Professor, School of Civil, Environmental, and Mining Engineering, University of Western Australia, Crawley, WA, Australia, July 2015.

Wisconsin Distinguished Professor, University of Wisconsin, Madison, Wisconsin, 2007, Geological Engineering, Civil & Environ Engineering (Emeritus May 2021).
Affiliate Professor, Nelson Institute for Environmental Studies, University of Wisconsin, Madison, Wisconsin, 2010-2015.
A.H. Fuller Professor, University of Washington, Seattle, WA, 2008- 2009.
Professor, University of Wisconsin, Madison, Wisconsin, 2000-2007 (joint appointment in Geological Engineering, Civil & Environmental Engineering).
Associate Professor, University of Wisconsin, Madison, Wisconsin, 1995-2000 (joint appointment in Geological Engineering, Civil & Environmental Engineering).
Assistant Professor, University of Wisconsin, Madison, Wisconsin, 1990-1995 (joint appointment in Geological Engineering, Civil & Environmental Engineering).

HONORS AND AWARDS

Professional
L. David Suits Award, Committee D35 on Geosynthetics, ASTM International, 2024
Kappe Lecturer, American Academy of Environmental Engineers and Scientists, 2024 ⓘ
Karl Terzaghi Award, Geo-Institute of the American Society of Civil Engineers, 2021
A. Ivan Johnson Outstanding Achievement Award, ASTM International, 2015
Fellow, ASTM International, 2011
Fellow, American Society of Civil Engineers, 2009
Fellow, Sigma Xi, Scientific Research Honor Society, 2017
Academy of Distinguished Alumni, University of Texas at Austin, 2009 ⓘ
Diplomate, Geotechnical Engineering, Academy of Geo-Professionals, 2009 ⓘ

Research
Lymon C. Reese Distinguished Lecturer, University of Texas at Austin, 2023
Best Paper Award, *Geotextiles and Geomembranes J.*, 2019
Best Paper Award, *Geosynthetics International J.*, 2019
Superior Paper Award, Waste Management Symposium, 2019, 2021, 2024
Spencer J. Buchanan Lecturer, Texas A&M University, 2014
Best Paper Award, Waste Management Symposium, 2014
G. Leonards Lecturer, Purdue University, 2013
Best Paper Honorable Mention (2nd Place), *Geosynthetics International*, 2013.
Ralph B. Peck Award, American Society of Civil Engineers, 2012
Outstanding Article on the Practice of Geotechnical Testing, ASTM International, 2011, 2013
Croes Medal, American Society of Civil Engineers, 1998 and 2008
Alfred P. Noble Prize, American Society of Civil Engineers, 2008
IJOG Excellent Paper Award, Intl. Assoc. Computer Methods & Advances in Geomechanics, 2008
Second Paper Award, Global Waste Management Symposium, 2008
Kellet Mid-Career Research Award, University of Wisconsin, 2005
Walter L. Huber Civil Engineering Research Award, ASCE, 2000
Casagrande Award, American Society of Civil Engineers, 1995
Middlebrooks Award, American Society of Civil Engineers, 1995, 2013
Collingwood Prize, American Society of Civil Engineers, 1994
Distinguished Young Faculty Award, U.S. Department of Energy, 1991
Presidential Young Investigator, National Science Foundation, 1991

Teaching
Polygon Outstanding Instructor Award, College of Engr., Univ. of Wisconsin, 1991, 93, 97
Outstanding Professor Award, ASCE Wisconsin Student Chapter, 1992
Top 100 Educators Award, Wisconsin Students Association, Univ. of Wisconsin, 1991

Professional Service
Honor Medal, Eurasian National University and Kazakhstan Geotechnical Society, 2013
Order of the Engineer, Geo Institute, 2011
Award of Merit, ASTM International, 2011
Richard S. Ladd Standards Development Award, Committee D18, ASTM International, 2002, 03, 04, 06, 08, 11
Special Service Award, Committee D18, ASTM International, 2007

Academics
Ford Foundation Fellowship, Univ. of Texas at Austin, 1989
John A. Focht Endowed Presidential Scholarship in Civil Engr., Univ. of Texas at Austin, 1988
Dawson Endowed Presidential Scholarship in Civil Engr., Univ. of Texas at Austin, 1986
Engineering Foundation Fellowship, University of Texas at Austin, 1985
John B. Carson Prize in Civil Engineering, Lehigh University, 1985
Phi Beta Kappa, Chi Epsilon, and Tau Beta Pi

CONGRESSIONAL TESTIMONY & DISCUSSION

Invited Testimony on Proposed USEPA Regulations Related to Coal Combustion Products; House Small Business Committee, Congressman H. Shuler, Chair (D-NC), 22 July 2010.

Invited Discussion on Environmental Regulation and Sustainable Materials Management; Senators for Environmental Policy and Sustainability, 29-30 May 2012.

LEADERSHIP DEVELOPMENT

Academic Leadership Program, Committee on Institutional Cooperation, Big10 Academic Alliance, 2010 – 2011.

Manager's Boot Camp, Center for Executive Education, Haas School of Business, University of California-Berkeley

Negotiations and Influence, Center for Executive Education, Haas School of Business, University of California-Berkeley

Philanthropy Fundamentals: Developing and Stewarding Donors, UW Foundation

UNIVERSITY SERVICE

Academic Council, UW Dept. of Civil and Environmental Engineering (1994-99, Chair 1997-99)
Academic Planning Council, UW Nelson Institute for Environmental Studies (2012-2016)
Ad Hoc Committee on Fossil Fuel Use and Climate Change, UW (2013-2014)
Admissions Chair, UW Geotechnical Engineering Program (1990-2006)
Becker Award Committee, UW Civil and Environmental Engineering (Chair 2002-04)
Bicentennial Commission, Future of Public Education Committee, UVA (2017-2022)
Bollinger Academic Staff Award Committee, UW (2010-11, Chair)
Byron Bird Award Committee, UW College of Engineering (1995)
Chancellor's Campus Budget Model Committee, UW (2013-2014)

Civil and Environmental Engineering Strategic Hiring Committee, UW (2010-12, Chair 2010)
Civil and Environmental Engineering Merit Committee, UW (1998, 2002, 2004-2006, Chair 2002)
Classroom Space Utilization Committee, Co-Chair, UW (2014)
Climate Change Solutions Committee, UW (2013-2015, Chair)
College of Engineering Search Committee for Executive Associate Dean, UW (Chair, 2014)
College of Engineering Leadership Council, UW (2013-2015)
College of Engineering Promotion and Tenure Committee, UW (2014-2015)
College of Engineering Search Committee for Associate Dean for Advancement, UW (2013)
College of Engineering Search Committee for Assistant Dean for Facilities, UW (2013)
College of Engineering Academic Planning and Curriculum Committee, UW (1996-99)
College of Engineering Curriculum Committee, UW (1997-99, 2002-04)
College of Engineering Diversity Committee, UW (2002-04)
Conflict of Interest Oversight Committee, University of Wisconsin (2000-02)
Governance Committee, UW Nelson Institute for Environmental Studies (2012-present).
Graduate Committee, UW Geological Engineering (1999-2006, Chair 1999-2001, 2003-2006)
Master Planning Committee, Deans' Council Representative, University of Virginia (2018-19)
Scholarship Committee, UW Dept. of Civil and Environmental Engineering (1998-2002)
Search Committee for Vice President for Research, UVA (2015-2017)
Search Committee for Assoc. Vice Chancellor for Facilities Planning & Mgmt., UW (Chair, 2012)
Search Committees for UW Geological Engineering (Chair, 1997-98, 2003-04)
Tau Beta Pi, Virginia Alpha Chapter, Advisor, 2019 – 2022.
Undergraduate Committee, UW Geological Engineering (Chair, 2002-2008)
University of Wisconsin Information Technology Committee (2010-12)
University of Wisconsin Honors Committee (2010-2011)

PROFESSIONAL SERVICE & AFFILIATIONS

National Academy of Engineering, 2012- present.
Science Advisory Board, Environmental Engineering Committee, US Environmental Protection Agency, 2015-2018 (committee disbanded).
Steering Committee, Performance and Risk Assessment Community of Practice, US Department of Energy, 2013-2022, co-Chair 2024-present.
Research Council, Environmental Research and Education Foundation, 2013-present, Vice Chair 2015-2016, Chair, 2017-2018.
External Advisory Board, School of Engineering, University of Connecticut (2019)
American Association for the Advancement of Science
Colorado School of Mines
- External Advisory Board, College of Earth Resource Sciences and Engineering (2016)
- External Advisory Board, Dept. of Geology and Geological Engineering (2015, 2018)
- External Advisory Board, College of Engineering (2012)

External Advisory Board, Department of Civil and Environmental Engineering, Vanderbilt University (2015-2022)
External Advisory Board, Engineering School of Sustainable Infrastructure & Environment, University of Florida (2011)
ASTM International
- D18 Executive Committee (2006-13, Vice Chair 2011-13)
- D18.04 - Hydrologic Properties of Soil & Rock (1991-present, Chair 1996-2006)
- D18.14 – Sustainable Geotechnical Construction (founding member, 2008-present)

D18.19 - Frozen Soil & Rock (1992-present)
Geo-Institute of the American Society of Civil Engineers (Fellow ASCE)
Board of Governors (Treasurer 2010-11, V. President, 2011-12, President 2012-13)
Org. Committee, Geo-Chicago 2016: Sustainability, Energy, & Geoenviron. Conf. (2014-16)
Awards Committee (Chair, 1999-01, Member 2023-current)
Editor-in-Chief, *JGGE*, 2004-06, Editor *JGGE*, 1996-99, Ombudsman *JGGE*, 2023-present.
Geoenvironmental Engineering Committee (1990-present, chair 1996-99)
Geo-Strata Magazine Task Force (1997-99)
Technical Publications Committee (1993-99, 2004-2006, BoG Liaison 2010-2013)
TPC Subcommittee on Policies for Specialty Conferences (1997-99)
American Geophysical Union
British Geotechnical Association
Canadian Geotechnical Society
International Geosynthetics Society
National Ground Water Association
North American Geosynthetics Society
Soil Science Society of America

PATENTS

Apparatus and Method for Testing the Hydraulic Conductivity of Geologic Materials, United States Patent No. 6,178,808.
Pressure Plate Extractor, United States Patent No. 6,718,835.
Bentonite Collars for Wellbore Casings, United States Patent No. 9,080,419.

LIVE INTERVIEWS, KEYNOTE AND SPECIAL LECTURES

Performance of Final Covers for Waste Containment Systems: Lessons Learned From the Field, Kappe Lecture, American Academy of Environmental Engineers and Scientists, Drexel University, 2 April 2025.
Elevated Temperature Landfills (ETLFs): Causation, Impacts, and Best Management Practices Learned from the Field, Kappe Lecture, University of Miami, 28 March 2025.
Does Harvesting Coal Ash for Use as Cementitious Material Promote Sustainability? Kappe Lecture, University of Nebraska-Lincoln, 20 February 2025.
Does Harvesting Coal Ash for Use as Cementitious Material Promote Sustainability? Kappe Lecture, Missouri University of Science and Technology, 12 February 2025.
Elevated Temperature Landfills (ETLFs): Causation, Impacts, and Best Management Practices Learned from the Field, Kappe Lecture, St. Louis University, 11 February 2025.
Elevated Temperature Landfills (ETLFs): Causation, Impacts, and Best Management Practices Learned from the Field, College of Engineering and Computer Science (CECE) Distinguished Lecturer Series, University of Central Florida, 5 December 2024.
Performance of Final Covers for Waste Containment Systems: Lessons Learned From the Field, Kappe Lecture, American Academy of Environmental Engineers and Scientists, University of New Mexico, 13 November 2024.
Does Harvesting Coal Ash for Use as Cementitious Material Promote Sustainability? George Mason Univ., Dept. of Civil Engineering Distinguished Speaker Lecture Series, 24 October 2024.

Elevated Temperature Landfills (ETLFs): Causation, Impacts, and Best Management Practices Learned from the Field, Kappe Lecture, American Academy of Environmental Engineers and Scientists. LA County Sanitation District, 25 June 2024, ; Clemson University, 10 October 2024, .

Performance of Waste Containment Systems for Long-Lived Waste Forms: Lessons Learned From the Field, Lymon C. Reese Distinguished Lecture, University of Texas at Austin, Austin, Texas, 14 April 2023.

Lessons Learned for the Practicing Engineer: How and When Geosynthetic Clay Liners are Effective for Containment, Keynote Lecture, GeoANZ 1 Advances in Geosynthetics, Brisbane, Queensland, Australia, 9 June 2022.

In-Service Condition of Radon Barriers over Uranium Mill Tailings Disposal Facilities in the United States, Craig H. Benson, National Council on Radiation Protection and Measurements 2022, Bethesda, Maryland, USA, 29 March 2022

Stress-Induced Porewater Pressures in the Vadose Zone Beneath a Composite-Lined Landfill, 3rd International Symposium on Coupled Phenomena in Environmental, Kyoto, Japan, October 2021.

Tackling Geoenvironmental Problems in the Unsaturated Zone: Principles and Practice, Keynote Lecture, 12th Asian Regional Conference of the International Association of Engineering Geologists, Jeju Island, Korea, September 2019.

Factors Affecting the Long-term Hydraulic Conductivity of Geosynthetic Clay Liners used in Liners, Workshop on Advances In Characterization of Hydraulic Barrier Performance of GCLs, ASTM International, Denver, Colorado, June 2019.

Using Life Cycle Analysis to Evaluate Options to Promote Infrastructure Sustainability, Sustainability in Urban Planning and Infrastructure, Celfi Sustentabilidida Y Desarrollo, Universidad Nacional de Córdoba, Córdoba, Argentina, May 2019.

Sustainability in Geoengineering: A New Paradigm for Engineering with Earthen Materials, 8th International Congress on Environmental Geotechnics, Hangzhou China, November 2018.

Water Balance Covers for Waste Containment: Engineering with Unsaturated Soils from Theory to Practice, Dr. Arthur T. Corey Distinguished Lecture Series, Colorado State University, Fort Collins, Colorado, October 2018.

Sustainability: Compelling Value Proposition for Engineers, Southwest Jiaotong University, Chengdu, China, November 2017.

Principles of Unsaturated Soil Behavior to Design Water Balance Covers for Waste Containment, Pan-Am UNSAT 2017, Dallas, Texas, November 2017.

Infusing Sustainability into Geotechnics: Opportunity for a New Value Proposition, Geo-Chicago 2016 - Sustainability, Energy, & the Geoenvironment, ASCE Geo-Institute, Chicago, August 2016.

Earthen & Geosynthetic Covers for Mine Waste Containment – Lessons Learned from Case Histories, Symposium on Caps and Covers for Mine Waste, Society for Mining Engineers, Pocatello, Idaho, April 2016.

Civil & Environmental Engineering: Creating a Compelling Value Proposition for the Future, Lehigh University, 150th Anniversary Reunion, April 2016.

Engineering Bentonite-Polymer Composite Materials for Extreme Environmental Applications, T.H. Wu Distinguished Lecture, Ohio State University, March 2016.

Are We Designing for Sustainability? Using Life Cycle Analysis to Assess Sustainability Accomplishment, Higley Endowed Lecture, Case Western Reserve University, April 2015.

Next Generation GCLs with Polymer-Bentonites for Extreme Environmental Applications, Keynote Lecture, Global Waste Research Institute, San Luis Obispo, CA, February 2015.

Landfill Covers: Water Balance, Unsaturated Soils, and the Pathway from Theory to Practice, Spencer J. Buchanan Lecture, Texas A&M University, November 2014.

Polymer-Modified Bentonites for Extreme Environmental Applications, Keynote Lecture, 7th Intl. Conference on Environmental Geotechnics, Melbourne, Australia, November 2014.

Strategies for Long-Term Monitoring and Stewardship, Best Practices for Risk-Informed Remedy Selection, Closure, and Post-Closure Control of Contaminated Sites, National Academy of Sciences, Washington, DC, January 2014.

Sustainable Closure of Waste Containment Systems Using Water Balance Covers: Lessons Learned from a Nationwide Field Experiment, Distinguished Lecture Series, University of Texas at Austin, November 2013.

Organoclays: Barrier Media for Managing Groundwater Flow and Transport At NAPL-Sites, University of Michigan, November 2013.

Solid Waste in the USA: Moving from Disposal to Sustainable Materials and Energy Management, University of California, Los Angeles, November 2013.

Organoclays: Novel Barrier Media for Managing Groundwater Flow and Transport at NAPL-Contaminated Sites, 11th G. A. Leonards Lecture, Purdue Geotechnical Society, April 2013.

Sustainability -- Opportunity for Innovation in the Solid Waste Industry, Engineering Society of Detroit, Keynote, April 2013.

Earthen and Geosynthetic Final Covers for Mine Waste Containment, Geosynthetics in Mining, Pocatello, ID, February 2013.

The Solid Waste Industry as a Sustainability Industry: Moving from Disposal to Materials and Energy Management, Keynote Lecture, Global Waste Management Symposium, Phoenix, AZ, October 2012.

Geosynthetic Clay Liners (GCLs): Lessons Learned from Full-Scale Applications, 2012 Ralph M. Peck Lecture, ASCE Geo Institute, Oakland, CA, March 2012.

Designing Water Balance Covers for Sustainable Waste Containment: Transitioning State-of-the-Art to State-of-the-Practice, *GeoCongress 2012*, ASCE Geo Institute, Oakland, CA, March 2012.

Unsaturated Geotechnics: Transitioning from State-of-the-Art to State-of-the Practice, 5th Asia-Pacific Conference on Unsaturated Soils, Bangkok, Thailand, February 2012.

Recycled Materials, Infrastructure, and Sustainability, Waste Management Association of Australia National Conference 2011, Adelaide, S. Australia, August 2011.

Novel Developments in Geosynthetic Clay Liner Technology, Innovations in Geosynthetic Materials Used in Environment and Infrastructure Symposium, Ministry of Environment and Ministry of Interior, Almaty, Republic of Kazakhstan, February 2011.

Role of Recycled Materials in Sustainable Infrastructure, Weston Roundtable Lecture, Nelson Institute for Environmental Studies, University of Wisconsin-Madison, January 2011.

Sustainable Bioreactor Landfills: North American State-of-the-Practice and State-of-the-Art in North America, Keynote Lecture, Sixth Asian Pacific International Landfill Symposium, Seoul, Korea, October 2010.

Physical and Chemical Processes Altering Geosynthetic Clay Liners In Situ, Distinguished Lecture Series, Department of Geology, Korea University, Seoul, Korea, October 2010.

Hydraulic & Chemical Properties of Geosynthetic Clay Liners Exhumed from Landfill Final Covers: Lessons Learned from a Decade of Research, Keynote Lecture, 3rd International Symposium on Geosynthetic Clay Liners, International Geosynthetics Society and SKZ – ConSem GmbH, Wurzburg, Germany, September 2010.

Evaluating our Predictive Capabilities in Geoenvironmental Engineering, Distinguished Lecture Series, Dept. of Civil and Materials Engineering, University of Illinois-Chicago, April 2010.

Prediction in Geoenvironmental Engineering: How Good are our Models?, Keynote Lecture, GeoFlorida 2010, Advances in Analysis, Design, and Modeling, ASCE Geo Institute, West Palm Beach, FL, February 2010.

Final Covers for Waste Containment: Lessons Learned from a Nationwide Field Experiment, Sowers State-of-the-Art Lecture, 12th Annual George F. Sowers Symposium, Georgia Institute of Technology, Atlanta, Georgia, May 2009.

Chemical Alterations and Their Impact on the Hydrologic Properties of Bentonite, Monash University, Melbourne, Victoria, Australia, December 2008.

Hydrology and Settlement in Bioreactor Landfills, Cutting Edge Technological Advances in Design and Operation, Reducing Leachate Quantity, Spatial Needs, and Costs, and Accelerating Landfill Gas Recovery Rates, World Bank, Washington, DC, November 2007.

Modeling Unsaturated Flow and Atmospheric Interactions, Keynote Speaker, Second International Conference on Mechanics of Unsaturated Soils, Weimar, Germany, March 2007.

Geosynthetic Clay Liners for Waste Containment: Panacea or Future Problem?, Geosynthetic Research Institute, Drexel University, Philadelphia, November 2005.

Effects of Heterogeneity on Mineral Fouling of Permeable Reactive Barriers, 2nd International Conference on Reactive Barriers, Belfast, Northern Ireland, March 2004.

Lessons Learned from North American Failures, Keynote Lecture, Fifth International Conference on Environmental Geotechnics, ISSMGE, Rio de Janeiro, Brazil, August 2002.

Waste Containment Systems: Strategies and Performance, Keynote Lecture, GeoEnvironment 2002, Australian-New Zealand Geomechanics Society, Newcastle, NSW, Australia, Nov. 2001

Engineered Barriers, Keynote Lecture, National Academy of Sciences, Washington, DC, July 2001.

Solid Waste Containment Systems, Keynote Lecture (with M. Manassero), GeoEng2000, Melbourne, Australia, November 2000.

Liners and Covers for Waste Containment, Keynote Speaker, Fourth Kansai International Geotechnical Forum, Creation of a New Geo-Environment, Japanese Geotechnical Society, Kyoto, Japan, June 2000

Environmental Geotechnics in the New Millennium, Keynote Speaker, Geotechnics for Developing Africa, African Geotechnical Society, Durban, South Africa, March 1999.

Final Covers for Waste Containment Systems: A North American Perspective, Keynote Speaker, XVII Conference of Geotechnics of Torino, Control and Management of Subsoil Pollutants, Italian Geotechnical Society, Torino, Italy, January 1999.

WEBINARS, SHORTCOURSES, AND VIDEO CLIPS

Black Goo: What is This Stuff and What Can We Do About It?, Engineering Science and Wastewater Technology Program, Waste Management Inc., 15 May 2025.

Black Goo: What is This Stuff and What Can We Do About It?, Kappe Lecture Webinar, American Academy of Environmental Engineers and Scientists, 20 March 2025.

Principles of Soil Physics and Vadose Zone Hydrology Applied to Practice, Electric Power Research Institute, 2024. *1 – What is the Vadose Zone?*; *2 – Quantifying Water Movement in the Vadose Zone*; *3 – Simulating Variably Saturated Flow for Practical Problems*; *4 – Measuring Hydraulic Properties in the Laboratory*; *5 – Measuring Hydraulic Properties in the Field*

Landfill Design for Coal Combustion Products, Electric Power Research Institute, 2024. *0–Introduction and course content*; *1–Basics of CCP Landfills: Foundational Principles and Concepts*; *2–Geosynthetics in CCP Landfill Design*; *3A–Principles of Compacted Soil Liners*; *3B–Construction Considerations for Compacted Clay Liners*; *4–Geosynthetic Clay Liners*; *5–*

Leachate Collection Systems ; *6–Final Covers for Waste Containment Facilities* ; *7–Performance Based Design: Making the Case for Alternative Liners* ; *8–Slope Stability for Landfills* .

Water Balance Covers: Principles, Performance Prediction, and Performance, Iowa Dept. of Natural Resources, 16 July 2024. Entire course ; Purpose and Scope ; Introduction to Water Balance Covers ; Water Balance Cover Modeling ; Monitoring and Case Histories .

Black Goo II - Understanding and Treating Black Goo in Landfills, SCS Learning Center, 23 April 2023.

Science Session - Black Goo: The Unseen Challenge in Modern Waste Management, Environmental Research and Education Foundation, 16 August 2023.

Identifying and Managing Elevated Temperature Landfills, SCS Learning Center, 27 July 2023.

Bentonite-Polymer Composite Geosynthetic Clay Liners for Heap Leach Liners, 5th International Conference on Heap Leach Mining Solutions 2022, Sparks, Nevada, 17 October 2022. [starts at 36:34].

Lessons-Learned in the Design and Construction of Capping Systems Used in the Closure of Near Surface Disposal Facilities, International Atomic Energy Agency's International Low Level Waste Disposal Network (DISPONET) Meeting on Lessons Learned from the Disposal of Low-Level Waste, Bulgaria, 4 October 2022.

Enhancing Armored Final Covers for Radioactive Waste Disposal Facilities Through Naturalization, Performance and Risk Assessment Community of Practice, US Dept. of Energy, Washington, DC, 17 August 2022.

Plastic Recycling and Upcycling as an Element of Sustainable Waste Management, USAID, Washington, DC, 12 August 2022.

In-Service Condition of Radon Barriers over Uranium Mill Tailings Disposal Facilities in the United States, National Council on Radiation Protection and Measurements 2022, Bethesda, Maryland, 29 March 2022.

PFAS Containment by Modern Liner Systems: the Good News – and the Bad!, Craig H. Benson and R. Kerry Rowe, International Geosynthetics Society-North America, 13 January 2022.

In-Service Condition of Final Covers Over Historic Uranium Mill Tailings Disposal Facilities, International Webinar Series - Geoenvironmental Engineering: Polluted Land, Waste Management & Sustainability/Resiliency, University of Illinois-Chicago, 15 October 2021.

A Career in Environmental Engineering with Geosynthetics, Simak's Geosynthetics Podcast, 16 March 2021.

Bentonite-Polymer Composite Geosynthetic Clay Liners for Containment of Highly Aggressive Leachates, International Webinar Series - Geoenvironmental Engineering: Polluted Land, Waste Management & Sustainability/Resiliency, University of Illinois-Chicago, 29 April 2021.

Performance-Based Landfill Liner Design, 21st National Course on Solid Waste Landfill Design, University of Wisconsin Madison, 23 March 2021.

Geosynthetic Clay Liners, 21st National Course on Solid Waste Landfill Design, University of Wisconsin Madison, 23 March 2021.

Final Covers for Waste Containment Facilities, 21st National Course on Solid Waste Landfill Design, University of Wisconsin Madison, 23 March 2021.

Elevated Temperature Landfills, 21st National Course on Solid Waste Landfill Design, University of Wisconsin Madison, 24 March 2021.

Stability of Final Covers, 21st National Course on Solid Waste Landfill Design, University of Wisconsin Madison, 23 March 2021.

In-Service Condition of Final Covers Over Historic Uranium Mill Tailings Disposal Facilities, Australasian Chapter of the International Geosynthetics Society, 24 February 2021.

Geosynthetics in Landfills: Accomplishments and Future Directions, GeoAmericas 2020, 4th Pan American Conference on Geosynthetics, 31 October 2020.
Fundamentals of GCLs as Exceptional Hydraulic Barriers, Webinar 1 of 4, GCL Webinar Series, 12 August 2020.
Bentonite-Polymer Composite GCLs for Aggressive Conditions, Webinar 2 of 4, GCL Webinar Series, 10 November 2020.
Evaluating Chemical Compatibility of Geosynthetic Clay Liners (GCLs), Webinar 3 of 4, GCL Webinar Series, 16 February 2021.
Practical Lessons Learned from Geosynthetic Clay Liner (GCL) Case Histories, Webinar 4 of 4, GCL Webinar Series, 4 August 2021.
GCL Tech Talk: The Science Behind the Magic of Bentonite, 7 April 2020.
GCL Tech Talk: Hydraulic Conductivity of Engineered Bentonite-Polymer Composite (BPC) Materials, 7 April 2020.
Engineering in Real Time: Accelerating the Innovation Cycle, with Jennifer Pulley and Innovation Now, National Public Radio, 13 July 2018.
The Internet of All Things: LinkLab Collaborative Environment, with Jennifer Pulley and Innovation Now, National Public Radio, 3 July 2018.
Coal Combustion Residual Containment, Craig H. Benson and John T. Allen, Geosynthetica, 15 July 2016.
Frac-Sand Mining Roundtable, with Joy Cardin on the Joy Cardin Show, Wisconsin Public Radio, 11 May 2015.
Coal Ash = Environmental Win (when you recycle it), with Dan Weissmann and Marketplace, National Public Radio, 28 April 2014.

PUBLICATIONS

Refereed Journal Articles: Environmental Containment Systems

Abichou, T., Powelson, D., Aitchison, E., Benson, C., and Albright, W. (2005), Water Balances in Vegetated Lysimeters at a Georgia Landfill, *Soil and Crop Society of Florida Proc.*, 64, 1-8.
Abichou, T., Benson, C., and Edil, T. (2004), Network Model for Hydraulic Conductivity of Sand-Bentonite Mixtures, *Canadian Geotech. J.*, 41(4), 698-712.
Abichou, T., Benson, C., and Edil, T. (2002), Micro-Structure and Hydraulic Conductivity of Simulated Sand-Bentonite Mixtures, *Clays and Clay Minerals*, 50(5), 537-545.
Abichou, T., Benson, C., and Edil, T. (2002), Foundry Green Sands as Hydraulic Barriers: Field Study, *J. Geotech. Geoenvironmental Eng.*, 128(3), 206-215.
Abichou, T., Benson, C., and Edil, T. (2000), Foundry Green Sands as Hydraulic Barriers: Laboratory Study, *J. Geotech. Geoenvironmental Eng.*, 126(12), 1174-1183.
Abu-Hassanein, Z., and Benson, C., and Blotz, L. (1996), Electrical Resistivity of Compacted Clays, *J. Geotech. Eng.*, 122(5), 397-407.
Abu-Hassanein, Z. and Benson, C., Wang, X., and Blotz, L. (1995), Determining Bentonite Content in Soil-Bentonite Mixtures Using Electrical Conductivity, *Geotech. Testing J.*, 19(1), 51-57.
Albrecht, B. and Benson, C. (2002), Predicting Airflow Rates in the Coarse Layer of Passive Dry Barriers, *J. Geotech. Geoenvironmental Eng.*, 128(4), 338-346.
Albrecht, B. and Benson, C. (2001), Effect of Desiccation on Compacted Natural Clays, *J. Geotech. Geoenvironmental Eng.*, 127(1), 67-76.
Albright, W., Benson, C., and Apiwantragoon, P. (2013), Field Hydrology of Landfill Final Covers with Composite Barrier Layers, *J. Geotech. Geoenvironmental Eng.*, 139(1), 1-12.

Albright, W., Benson, C., Gee, G., Abichou, T., Tyler, S., Rock, S. (2006), Field Performance of Three Compacted Clay Landfill Covers, *Vadose Zone J.*, 5(6), 1157-1171.

Albright, W., Benson, C., Gee, G., Abichou, T., Tyler, S., Rock, S. (2006), Field Performance of a Compacted Clay Landfill Final Cover at A Humid Site, *J. Geotech. Geoenvironmental Eng.*, 132(11), 1393-1403.

Albright, W., Benson, C., Gee, G., Roesler, A., Abichou, T., Apiwantragoon, P., Lyles, B., and Rock, S. (2004), Field Water Balance of Landfill Final Covers. *J. Environ. Quality*, 33(6), 2317-2332.

Akpinar, M. and Benson, C. (2005), Effect of Temperature on Shear Strength of Two Geomembrane-Geotextile Interfaces, *Geotextiles and Geomembranes*, 23, 443-453.

Apiwantragoon, P., Benson, C., and Albright, W. (2014), Field Hydrology of Water Balance Covers for Waste Containment, *J. Geotech. Geoenvironmental Eng.*, 04014101.

Bareither, C., Foley, J., and Benson, C. (2015), Using Surrogate Meteorological Data to Predict the Hydrology of a Water Balance Cover, *J. Geotech. Geoenvironmental Eng.*, 04015092.

Bareither, C., Benson, C., Barlaz, M., Edil, T., and Tolaymat, T. (2010), Performance of North American Bioreactor Landfills: I. Leachate Hydrology and Waste Settlement, *J. Environmental Engineering*, 136(8), 824-838.

Bareither, C., Benson, C., and Edil, T. (2012), Effects of Waste Composition and Decomposition on the Shear Strength of Municipal Solid Waste, *J. Geotech. Geoenviron. Eng.*, 138(10), 1161-1174.

Bareither, C., Benson, C., Cook, E., and Scalia, J. (2020), Hydraulic and Mechanical Behavior of Municipal Solid Waste and High-Moisture Waste Mixtures, *Waste Management*, 105, 540–549.

Barlaz, M., Bareither, Hossain, A., Saquing, J., Mezzari, I., Benson, C., and Tolaymat, T. (2010), Performance of North American Bioreactor Landfills: II. Chemical and Biological Characteristics, *J. Environmental Engineering*, 136(8), 838-853.

Benson, C., Albright, W., Waugh, W., Apiwantragoon, P., Tigar, A., and Holbrook, D. (2024), Field Hydrology of Armored Earthen Final Covers With and Without Vegetation, *J. Geotech. Geoenvironmental Eng.*, 150(1), 04023125. **(Editor's Choice)**

Benson, C., Chen, J., Likos, W., and Edil, T. (2018), Hydraulic Conductivity of Compacted Soil Liners Permeated with Coal Combustion Product Leachates, *J. Geotech. Geoenvironmental Eng.*, 144(4), 04018011. **(Editor's Choice)**

Benson, C. and Yesiller, N. (2016), Variability of Saturated Hydraulic Conductivity Measurements Made Using a Flexible-Wall Permeameter, *Geotech. Testing J.*, doi: 10.1520/GTJ20150138, 39(3), 476-491.

Benson, C., Edil, T., and Wang, X. (2012), Evaluation of a Final Cover Slide at a Landfill with Recirculating Leachate, *J. Geotextiles and Geomembranes*, 35, 100-106.

Benson, C., Oren, A., Gates, W. (2010), Hydraulic Conductivity of Two Geosynthetic Clay Liners Permeated with a Hyperalkaline Solution, *J. Geotextiles and Geomembranes*, 28(2), 206-218.

Benson, C., Kucukkirca, I., and Scalia, J. (2010), Properties of Geosynthetics Exhumed from the Final Cover at a Solid Waste Landfill, *J. Geotextiles and Geomembranes*, 28, 536-546.

Benson, C. and Meer, S. (2009), Relative Abundance of Monovalent and Divalent Cations and the Impact of Desiccation on Geosynthetic Clay Liners, *J. Geotech. Geoenvironmental Eng.*, 135(3), 349-358.

Benson, C., Thorstad, P., Jo, H., and Rock, S. (2007), Hydraulic Performance of Geosynthetic Clay Liners in a Landfill Final Cover, *J. Geotech. Geoenvironmental Eng.*, 133(7), 814-827.

Benson, C., Barlaz, M., Lane, D., and Rawe, J. (2007), Practice Review of Five Bioreactor/Recirculation Landfills, *Waste Management*, 27(1), 13-29.

Benson, C., Sawangsuriya, A., Trzebiatowski, B., and Albright, W. (2007), Post-Construction Changes in the Hydraulic Properties of Water Balance Cover Soils, *J. Geotech. Geoenvironmental Eng.*, 133(4), 349-359.

Benson, C., Abichou, T., and Jo, H. (2004), Forensic Analysis of Excessive Leakage from Lagoons Lined with a Composite GCL, *Geosynthetics Intl.*, 11(3), 242-252.

Benson, C. (2001), Waste Containment: Strategies and Performance, *Australian Geomechanics*, 36(4), 1-25.

Benson, C., Abichou, T., Albright, W., Gee, G., and Roesler, A. (2001), Field Evaluation of Alternative Earthen Final Covers, *Intl. J. Phytoremediation*, 3(1), 1-21.

Benson, C., Daniel, D., and Boutwell, G. (1999), Field Performance of Compacted Clay Liners, *J. Geotech. Geoenvironmental Eng.*, 125(5), 390-403.

Benson, C., Gunter, J., Boutwell, G., Trautwein, S., and Berzanskis, P. (1997), Comparison of Four Methods to Assess Hydraulic Conductivity, *J. Geotech. Geoenvironmental Eng.*, 123(10), 929-937.

Benson, C., Olson, M., and Bergstrom, W. (1996), Temperatures of Insulated Landfill Liner, *J. Transportation Research Board*, 1534, 24-31.

Benson, C. and Trast, J. (1995), Hydraulic Conductivity of Thirteen Compacted Clays, *Clays and Clay Minerals*, 43(6), 669-681.

Benson, C., Chamberlain, E., Erickson, A., and Wang, X. (1995), Assessing Frost Damage in Compacted Clay Liners, *Geotech. Testing J.*, 18(3), 324-333.

Benson, C., Abichou, T., Olson, M., and Bosscher, P. (1995), Winter Effects on the Hydraulic Conductivity of Compacted Clay, *J. Geotech. Eng.*, 121(1), 69-79.

Benson, C., Zhai, H., and Wang, X. (1994), Estimating Hydraulic Conductivity of Compacted Clay Liners, *J. Geotech. Eng.*, 120(2), 366-387.

Benson, C. and Daniel, D. (1994), Minimum Thickness of Compacted Soil Liners: I-Stochastic Models, *J. Geotech. Eng.*, 120(1), 129-152.

Benson, C. and Daniel, D. (1994), Minimum Thickness of Compacted Soil Liners: II-Analysis and Case Histories, *J. Geotech. Eng.*, 120(1), 153-172.

Benson, C., Bosscher, P., Lane, D., and Pliska, R. (1994), Monitoring System for Hydrologic Evaluation of Landfill Final Covers, *Geotech. Testing J.*, 17(2), 138-149.

Benson, C., Zhai, H. and Rashad, S. (1994), Statistical Sample Size for Construction of Soil Liners, *J. Geotech. Eng.*, 120(10), 1704-1724.

Benson, C. and Othman, M. (1993), Hydraulic and Mechanical Characteristics of Compacted Municipal Solid Waste Compost, *Waste Management and Research*, 11(1), 127-142.

Benson, C. (1993), Probability Distributions for Hydraulic Conductivity of Compacted Soil Liners, *J. Geotech. Eng.*, 119(3), 471-486.

Benson, C. and Othman, M. (1993), Hydraulic Conductivity of Compacted Clay Frozen and Thawed In Situ, *J. Geotech. Eng.*, 119(2), 276-294.

Benson, C. and Daniel, D. (1990), Influence of Clods on Hydraulic Conductivity of Compacted Clay, *J. Geotech. Eng.*, 116(8), 1231-1248.

Blotz, L., Benson, C., and Boutwell, G. (1998), Estimating Optimum Water Content and Maximum Dry Unit Weight for Compacted Clays, *J. Geotech. Geoenvironmental Eng.*, 124(9), 907-912.

Bohnhoff, G., Ogorzalek, A., Benson, C., Shackelford, C., and Apiwantragoon, P. (2009), Field Data and Water-Balance Predictions for a Monolithic Cover in a Semiarid Climate, *J. Geotech. Geoenvironmental Eng.*, 135(3), 333-348.

Bradshaw, S. and Benson, C. (2014), Effect of Municipal Solid Waste Leachate on Hydraulic Conductivity and Exchange Complex of Geosynthetic Clay Liners, *J. Geotech. Geoenvironmental Eng.*, 04013038.

Bradshaw, S., Benson, C., and Scalia, J. (2013), Cation Exchange During Subgrade Hydration and Effect on Hydraulic Conductivity of Geosynthetic Clay Liners, *J. Geotech. Geoenvironmental Eng.*, 139(4), 526-538.

Bradshaw, S., Benson, C., and Rauen, T. (2015), Hydraulic Conductivity of Geosynthetic Clay Liners to Recirculated Municipal Solid Waste Leachates, *J. Geotech. Geoenvironmental Eng.*, 04015074.

Chen, J., Benson, C., Edil, T., and Likos, W. (2018), Hydraulic Conductivity of Geosynthetic Clay Liners with Sodium Bentonite to Coal Combustion Product Leachates, *J. Geotech. Geoenvironmental Eng.*, 144(3), 0401800.

Chen, J., Gustitus, S., Lin, H. and Benson, C. (2024), Shear Strength of Bentonite-Polymer Composite Geosynthetic Clay Liners and Geomembranes, *Environmental Geotechnics*, 11(2), 102-111, https://doi.org/10.1680/jenge.22.00071.

Chen, J., Salihoglu, S., Benson, C., Likos, W., and Edil, T. (2019), Hydraulic Conductivity of Bentonite-Polymer Composite Geosynthetic Clay Liners Permeated with Coal Combustion Product Leachates, *J. Geotech. Geoenvironmental Eng.*, 145(9), 04019038.

Daniel, D. and Benson, C. (1990), Water Content-Density Criteria for Compacted Soil Liners, *J. Geotech. Eng.*, 116(12), 1811-1830.

Eun, J., Tinjum, J., Benson, C., and Edil, T. (2017), Equivalent Transport Parameters for Volatile Organic Compounds in Coextruded Geomembrane Containing Ethylene-Vinyl Alcohol, *J. Geotech. Geoenvironmental Eng.*, 144(7), 04018040.

Eun, J., Tinjum, J., Benson, C., and Edil, T. (2017), Comparison of Volatile Organic Compound (VOC) Transport between Composite Liners with HDPE and Ethylene-Vinyl Alcohol (EVOH) Co-Extruded Geomembranes, *J. Geotech. Geoenvironmental Eng.*, 04017010.

Eun, J., Tinjum, J., Benson, C., and Edil, T. (2018), Methane Transport Through Simulated Landfill Covers with a PE Geofilm or Ethylene-Vinyl Alcohol (EVOH), LLDPE, or PVC Geomembranes *J. Environmental Eng.*, 144(2): 04017106.

Foose, G., Benson, C., and Edil, T. (2002), Comparison of Solute Transport in Three Composite Landfill Liners, *J. Geotech. Geoenvironmental Eng.*, 128(5), 391-403.

Foose, G., Benson, C., and Edil, T. (2001), Predicting Leakage Through Composite Landfill Liners, *J. Geotech. Geoenvironmental Eng.*, 127(6), 510-520.

Foose, G., Benson, C., and Edil, T. (2001), Analytical Equations for Predicting Concentration and Mass Flux from Composite Landfill Liners, *Geosynthetics Intl.*, 8(6), 551-575.

Fuhrmann, M., Caldwell, T. Likos, Waugh, W., Williams, M., Benson, C. (2023), Evolving Radon Diffusion Through Earthen Barriers At Uranium Waste Disposal Sites, *J. Environmental Radioactivity*, 262, 107140, https://doi.org/10.1016/j.jenvrad.2023.107140.

Fuhrmann, M., Benson, C., Likos, W., Stefani, N., Michaud, A., Waugh, W., Williams, M. (2021), Radon Fluxes at Four Uranium Mill Tailings Disposal Sites After 20 Years of Service, *J. Environmental Radioactivity*, 237, 106719.

Fuhrmann, M. , Michaud, A., Salay, M., Benson, C., Likos, W., Stefani, N., Waugh, W., Williams, M. (2019), Lead-210 Profiles in Radon Barriers, Indicators of Long-Term Radon-222 Transport, *Applied Geochemistry*, 110, 104434.

Geng, W., Liu, M., Benson, C., Likos, W., and Gadikota, G. (2024), Morphological Controls on Hydraulic Conductivity and Viscosity of Bentonite-Polymer Composite, *Environmental Geotechnics*, 11(2), 136–144, https://doi.org/10.1680/jenge.21.00125.

Geng, W., Salihoglu, H., Likos, W., and Benson, C. (2024), Index Tests for Geosynthetic Clay Liners Containing Bentonite-Polymer Composites, *Environmental Geotechnics*, 11(2), 112–123 https://doi.org/10.1680/jenge.22.00072.

Gulec, S., Benson, C., and Edil, T. (2005), Effect of Acidic Mine Drainage (AMD) on the Mechanical and Hydraulic Properties of Three Geosynthetics, *J. Geotech. Geoenvironmental Eng.*, 131(8), 937-950, https://doi.org/10.1680/jenge.22.00072.

Gulec, S., Edil, T., and Benson, C. (2004), Effect of Acidic Mine Drainage (AMD) on the Polymer Properties of an HDPE Geomembrane, *Geosynthetics Intl.*, 11(2), 60-72.

Gustitus, S., Nguyen, D., Chen, J., and Benson, C. (2021), Quantifying Polymer Loading in Bentonite-Polymer Composites Using Loss on Ignition and Total Carbon Analyses, *Geotech. Testing J.*, doi:10.1520/GTJ20200007.

Hao, Z., Sun, M., Ducoste, J., Benson, C., Luettich, S., Castaldi, M., and Barlaz, M. (2017), Heat Generation and Accumulation in Municipal Solid Waste Landfills, *Environmental Science & Technology*, 51, 12434-12442.

Hou, J., Sun, R., and Benson, C. (2023), Hydrodynamic Assessment of Bentonite Granule Size and Swelling on Hydraulic Conductivity of Geosynthetic Clay Liners, *Geotextiles and Geomembranes*, 51, 93-103.

Hou, J., Xie, X., and Benson, C. (2025), Effect of Geomembrane Texturing Method on Geomembrane-Dry GCL Interface Shear Behavior, *Geotextiles and Geomembranes*, 53, 1185-1199.

Jacobson, K., Lee, S., Somerville, R., McKenzie, D., Benson, C., and Pedersen, J. (2010), Transport of the Pathogenic Prion Protein Through Soils, *J. Environmental Quality*, 39, 1145–1152.

Jacobson, K., Lee, S., McKenzie, D., Benson, C., and Pedersen, J. (2008), Transport of the Pathogenic Prion Protein Through Landfill Materials, *Enviro. Science & Technology*, 43(6), 2022-2028.

Jo, H., Benson, C., and Edil, T. (2006), Rate-Limited Cation Exchange in Thin Bentonitic Barrier Layers, *Canadian Geotech. J.*, 43, 370-391.

Jo, H., Benson, C., Lee, J., Shackelford, C., and Edil, T. (2005), Long-Term Hydraulic Conductivity of a Non-Prehydrated Geosynthetic Clay Liner Permeated with Inorganic Salt Solutions, *J. Geotech. Geoenvironmental Eng.*, 131(4), 405-417.

Jo, H., Benson, C., and Edil, T. (2004), Hydraulic Conductivity and Cation Exchange in Non-Prehydrated and Prehydrated Bentonite Permeated with Weak Inorganic Salt Solutions, *Clays and Clay Minerals*, 52(6), 661-679.

Jo, H., Katsumi, T., Benson, C., and Edil, T. (2001), Hydraulic Conductivity and Swelling of Non-Prehydrated GCLs Permeated with Single Species Salt Solutions, *J. of Geotech. Geoenvironmental Eng.*, 127(7), 557-567.

Katsumi, T., Benson, C., Foose, G., and Kamon, M. (2001), Performance-Based Design of Landfill Liners, *Engineering Geology*, 60, 139-148.

Katsumi, T., Benson, C., Foose, G., and Kamon, M. (1999), Evaluation of the Performance of Landfill Liners, *J. Japan Society of Waste Management*, 10(1), 75-85.

Khire, M., Benson, C., and Bosscher, P. (2000), Capillary Barriers: Design Variables and Water Balance, *J. Geotech. Geoenvironmental Eng.*, 126(8), 695-708.

Khire, M., Benson, C., and Bosscher, P. (1999), Field Data from a Capillary Barrier in Semi-Arid and Model Predictions with UNSAT-H, *J. Geotech. Geoenvironmental Eng.*, 125(6), 518-528.

Khire, M., Benson, C., and Bosscher, P. (1997), Water Balance of Two Earthen Landfill Caps in a Semi-Arid Climate, *Land Contamination and Reclamation*, 5(3), 195-202.

Khire, M., Benson, C., and Bosscher, P. (1997), Water Balance Modeling of Earthen Final Covers, *J. Geotech. Geoenvironmental Eng.*, 123(8), 744-754.

Kim, H. and Benson, C. (2004), Contributions of Advective and Diffusive Oxygen Transport Through Multilayer Composite Caps Over Mine Waste, *J. Contaminant Hydrology*, 71(1-4), 193-218.

Kolstad, D., Benson, C., and Edil, T. (2004), Hydraulic Conductivity and Swell of Nonprehydrated GCLs Permeated with Multispecies Inorganic Solutions, *J. Geotech. Geoenvironmental Eng.*, 130(12), 1236-1249.

Kolstad, D., Benson, C., Edil, T., and Jo, H. (2004), Hydraulic Conductivity of a Dense Prehydrated GCL Permeated with Aggressive Inorganic Solutions, *Geosynthetics Intl.*, 11(3), 233-240.

Kraus, J., Benson, C., Erickson, A., and Chamberlain, E. (1997), Freeze-Thaw and Hydraulic Conductivity of Bentonitic Barriers, *J. Geotech. Geoenvironmental Eng.*, 123(3) 229-238.

Kraus, J., Benson, C., Maltby, V., and Wang, X. (1997), Field and Laboratory Hydraulic Conductivity of Compacted Papermill Sludges, *J. Geotech. Geoenviron. Eng.*, 123(7), 654-662.

Lee, J., Shackelford, C., Benson, C., Jo, H., and Edil, T. (2005), Correlating Index Properties and Hydraulic Conductivity of Geosynthetic Clay Liners, *J. Geotech. Geoenvironmental Eng.*, 131(11), 1319-1329.

Li, Q., Chen, J., Benson, C., and Chen, D. (2020), Hydraulic Conductivity of Bentonite-Polymer Composite Geosynthetic Clay Liners Permeated with Bauxite Liquor, *J. Geotextiles and Geomembranes*, 49, 420-429.

Lin, L. and Benson, C. (2000), Effect of Wet-Dry Cycling on Swelling and Hydraulic Conductivity of Geosynthetic Clay Liners, *J. Geotech. Geoenvironmental Eng.*, 126(1), 40-49.

Ma, X., Benson, C., D. McKenzie, J. Aiken, and J. Pedersen (2007), Adsorption of Pathogenic Prion Protein to Quartz Sand, *Environmental Science and Technology*, 41(7), 2324-2330.

Makusa, G., Bradshaw, S., Berns, E., Benson, C., Knutsson, S. (2014), Freeze-Thaw Cycling and the Hydraulic Conductivity of Geosynthetic Clay Liners Concurrent with Cation Exchange, *Canadian Geotech. J.*, 51(6), 591-598. **(Editor's Choice)**

Meer, S. and Benson, C. (2007), Hydraulic Conductivity of Geosynthetic Clay Liners Exhumed from Landfill Final Covers, *J. Geotech. Geoenvironmental Eng.*, 133(5), 550-563.

Meerdink, J., Benson, C., and Khire, M. (1995), Unsaturated Hydraulic Conductivity of Two Compacted Barrier Soils, *J. Geotech. Eng.*, 122(7), 565-576.

Ogorzalek, A., Bohnhoff, G., Shackelford, C., Benson, C., and Apiwantragoon, P. (2008), Comparison of Field Data and Water-Balance Predictions for a Capillary Barrier Cover. *J. Geotech. Geoenvironmental Eng.*, 134(4), 470-486.

Othman, M. and Benson, C. (1993), Effect of Freeze-Thaw on the Hydraulic Conductivity and Morphology of Compacted Clay, *Canadian Geotech. J.*, 30(2), 236-246.

Othman, M. and Benson, C. (1993), Effect of Freeze-Thaw on the Hydraulic Conductivity of Three Compacted Clays from Wisconsin, *J. Transportation Research Board*, 1369, 118-125.

Palmer, B., Edil, T. and C. H. Benson (2000), Liners for Waste Containment Constructed with Class F and C Fly Ashes, *J. Hazardous Materials*, 18(2-3), 133-161.

Park, M., Benson, C., and Edil, T. (2012), Comparison of Batch and Double Compartment Tests for Measuring VOC Transport Parameters in Geomembranes, *J. Geotextiles and Geomembranes*, 31, 15-30.

Park, M., Edil, T., and Benson, C (2011), Modeling Volatile Organic Compound Transport in Composite Liners, *J. Geotech. Geoenvironmental Eng.*, 138(6), 641-657.

Pedersen, J., Johnson, C., Bell, C., Jacobson, K., Benson, C., McKenzie, D., and Aiken, J. (2009), Soil and the Transmission of Prion Diseases, *Geochimica et Cosmochimica Acta Suppl.*, 73, A1007.

Pedersen, J., McMahon, K., and Benson, C. (2006), Prions: Novel Pathogens of Environmental Concern?, *J. of Environmental Engineering*, 132(9), 967-969.

Rustick, J., Kosson, D., Krahn, S., Ryan, M., Benson, C., and Clarke, J. (2015), Comparison of Low Level Waste Disposal Facilities at Major Department of Energy Sites, *Remediation*, 26(1), DOI: 10.1002/rem, 69-91.

Scalia, J., Benson, C., and Finnegan, M. (2018), Alternate Procedures for Swell Index Testing of Granular Bentonite from GCLs, *Geotechnical Testing J.*, 0149-6115.

Scalia, J., Benson, C., Albright, W., Smith, B., and Wang, X. (2017), Properties of Barrier Components in a Composite Cover after 14 Years of Service and Differential Settlement, *J. Geotech. Geoenvironmental Eng.*, 04017055.

Scalia, J. and Benson, C. (2016), Polymer Fouling and Hydraulic Conductivity of Mixtures of Sodium Bentonite and a Bentonite-Polymer Composite, *J. Geotech. Geoenvironmental Eng.*, 04016112. (**Research Highlight, April 2017 Issue**)

Scalia, J., Benson, C., Bohnhoff, G., Edil, T., and Shackelford, C. (2014) Long-Term Hydraulic Conductivity of a Bentonite-Polymer Composite Permeated with Aggressive Inorganic Solutions, *J. Geotech. Geoenvironmental Eng.*, 04013025.

Scalia, J. and Benson, C. (2011), Hydraulic Conductivity of Geosynthetic Clay Liners Exhumed from Landfill Final Covers with Composite Barriers, *J. Geotech. Geoenvironmental Eng.*, 137(1), 1-13.

Scalia, J. and Benson, C. (2010), Preferential Flow in Geosynthetic Clay Liners Exhumed from Final Covers with Composite Barriers, *Canadian Geotechnical J.*, 47, 1101-1111.

Scalia, J. and Benson, C. (2010), Effect of Permeant Water on the Hydraulic Conductivity of Exhumed Geosynthetic Clay Liners, *Geotechnical Testing J.*, 33(3), 1-11.

Scalia, J., Bohnhoff, G., Shackelford, C., Benson, C., Sample-Lord, K., Malusis, M., and Likos, W. (2018), Enhanced Bentonites for Containment of Inorganic Waste Leachates by GCLs, *Geosynthetics Intl.*, 1072-6349, 1-20 (**Best Paper Award for 2018**).

Setz, M., Benson, C., Bradshaw, S., and Tian, K. (2018), Lithium Extraction to Determine Ammonium in the Exchange Complex of Bentonite, *Geotechnical Testing J.*, ISSN 0149-6115.

Setz, M., Tian, K., Benson, C., and Bradshaw, S. (2017), Effect of Ammonium on the Hydraulic Conductivity of Geosynthetic Clay Liners, *J. Geotextiles and Geomembranes*, 45 (2017) 665-673.

Shackelford, C., Benson, C., Katsumi, T., and Edil, T. (2000), Evaluating the Hydraulic Conductivity of GCLs Permeated with Non-Standard Liquids, *J. Geotextiles Geomembranes*, 18(2-3), 133-161.

Smesrud, J., Benson, C., Albright, W., Richards, J., Wright, S., Israel, T., and Goodrich, K. (2012), Using Pilot Test Data to Refine an Alternative Cover Design in Northern California, *Intl. J. Phytoremediation*, 14(S1), 76-93.

Tinjum, J., Benson, C., and Blotz, L. (1997), Soil-Water Characteristic Curves for Compacted Clays, *J. Geotech. Geoenvironmental Eng.*, 123(11), 1060-1070.

Tian, K. and Benson, C. (2018), Radiation Dose and Antioxidant Depletion in HDPE Geomembranes, *J. Geotextiles and Geomembranes*, 46, 426-435. (**Best Paper Award for 2018**)

Tian, K., Benson, C., and Likos, W. (2016), Hydraulic Conductivity of Geosynthetic Clay Liners to Low-Level Radioactive Waste Leachate, *J. Geotech. Geoenvironmental Eng.*, 04016037.

Tian, K., Likos, W., and Benson, C. (2019), Polymer Elution and Hydraulic Conductivity of Bentonite-Polymer Composite Geosynthetic Clay Liners, *J. Geotech. Geoenvironmental Eng.*, 145(10), 04019071.

Tian, K., Benson, C., Tinjum, J. and Edil, T. (2017), Antioxidant Depletion and Service Life Prediction for HDPE Geomembranes Exposed to Low-Level Radioactive Waste Leachate, *J. Geotech. Geoenvironmental Eng.*, 04017011. **(Editor's Choice)**.

Tian, K., Benson, C., and Tinjum, J. (2017), Chemical Characteristics of Leachate in Low-Level Radioactive Waste Disposal Facilities, *J. Hazardous, Toxic, & Radioactive Waste Mgmt.*, 21(4), 04017010. **(Editor's Choice)**.

Trast, J. and Benson, C. (1995), Estimating Field Hydraulic Conductivity of Compacted Clay, *J. Geotech. Eng.*, 121(10), 736-740.

Tuspsakhare, S. Moutushi, T. Luettich, S., Benson, C., Barlaz, M., and Castaldi, M. (2020), The Impact of Pressure, Moisture and Temperature on Pyrolysis of Municipal Solid Waste under

Simulated Landfill Conditions and Relevance to the Field Data from Elevated Temperature Landfill, *Science of the Total Environment*, 723, 138031.

Wang, X. and Benson, C. (1999), Hydraulic Conductivity Testing of Geosynthetic Clay Liners Using the Constant Volume Method, *Geotechnical Testing J.*, 22(4), 277-283.

Wang, X. and Benson, C. (1995), Infiltration and Field-Saturated Hydraulic Conductivity of Compacted Clay, *J. Geotech. Eng.*, 121(10), 713-722.

Waugh, W., Benson, C., and Albright, W. (2015), Evaluation of Soil Manipulation Methods to Transform Engineered Earthen Covers for Long-Term Waste Containment, *J. Environmental Quality*, doi:10.2134/jeq2015.01.0001.

Williams, T., Benson, C., Tian, K., Yesiller, N., and Hanson, J., (2024), Hydraulic and Geochemical Characteristics of a Geosynthetic Clay Liner Exhumed from an Exposed Composite Liner, *J. Geotech. Geoenvironmental Eng.*, 150(5), 05024002.

Yesiller, N., Hanson, J., Risken, J., Benson, C., Abichou, T., and Darius, J. (2019), Hydration Fluid and Field Exposure Effects on Moisture-Suction Response of Geosynthetic Clay Liners, *J. Geotech. Geoenvironmental Eng.*, 145(4): 04019010 **(Editor's Choice)**

Zhai, H. and Benson, C. (2006), The Log-Normal Distribution for Hydraulic Conductivity of Compacted Clays: Two or Three Parameters?, *Geotechnical and Geological Engineering*, 24(5), 1149-1162.

Refereed Journal Articles: Sustainability and Sustainable Infrastructure

Aguirre-Villegas, H. and Benson, C. (2022), Expectations for Coal Demand in Response to Evolving Carbon Policy and Climate Change Awareness, *Energies*, 15, 3739.

Aguirre-Villegas, H. and Benson, C. (2017), Case History of Environmental Impacts of an Indonesian Coal Supply Chain, *J. Cleaner Production*, 157, 47-56.

Bareither, C., Wolfe, G., McMahon, K., and Benson, C. (2013), Microbial Diversity and Dynamics During Methane Production from Municipal Solid Waste, *Waste Management*, 30, 1982-1992.

Bareither, C., Breitmeyer, R., Benson, C., Barlaz, M., and Edil, T. (2012), Deer Track Bioreactor Experiment: Field-Scale Evaluation of Municipal Solid Waste Bioreactor Performance, *J. Geotech. Geoenvironmental Eng.*, 138(6), 658-670.

Bareither, C., Benson, C., and Edil, T. (2012), Compression Behavior of Municipal Solid Waste: Immediate Compression, *J. Geotech. Geoenvironmental Eng.*, 138(9), 1047-1062.

Bareither, C., Benson, C., and Edil, T. (2013), Compression of Municipal Solid Waste in Bioreactor Landfills: Mechanical Creep and Biocompression, *J. Geotech. Geoenvironmental Eng.*, 139(7), 1007-1021.

Bareither, C., Benson, C., Edil, T., and Barlaz, M. (2012), Abiotic and Biotic Compression of Municipal Solid Waste, *J. Geotech. Geoenvironmental Eng.*, 138(8), 877-888.

Bradshaw, S., Aguirre-Villegas, H., Boxman, S., and Benson, C. (2025), Material Recovery Facilities (MRFs) in the United States: Operations, Revenue, and the Impact of Scale, *Waste Management*, 193, 317-327.

Breitmeyer, R. and Benson, C. (2014), Evaluation of Parameterization Techniques for Unsaturated Hydraulic Conductivity Functions for Municipal Solid Waste, *Geotech. Testing J.*, 37(4) 1-10.

Breitmeyer, R., Benson, C., and Edil, T. (2020), Effect of Changing Unit Weight and Decomposition on Unsaturated Hydraulic Properties of Municipal Solid Waste In Bioreactor Landfills, *J. Geotech. Geoenvironmental Eng.*, 146(5): 04020021.

Breitmeyer, R., Benson, C., and Edil, T. (2019), Effects of Compression and Decomposition on Saturated Hydraulic Conductivity of Municipal Solid Waste in Bioreactor Landfills, *J. Geotech. Geoenvironmental Eng.*, 145(4): 04019011. (**Smart Brief**)

Benson, C. and Khire, M. (1994), Reinforcing Sand with Strips of Reclaimed High Density Polyethylene, *J. Geotech. Eng.*, 120(5), 838-855.

Bin-Shafique, S., Benson, C., Edil, T., and Hwang, K. (2006), Leachate Concentrations from Water Leach and Column Leach Tests on Fly-Ash Stabilized Soil, *Environmental Engineering Science*, 23(1), 51-65.

Bin-Shafique, S., Edil, T., and Benson, C. (2004), Incorporating a Fly Ash Stabilized Layer into Pavement Design: Case Study, *Geotechnical Engineering*, 157(4), 239-249.

Camargo, F., Edil, T., and Benson, C. (2013), Strength and Stiffness of Recycled Pavement Materials Stabilized with Fly Ash: A Laboratory Study, *Road Materials and Pavement Design*, 14(2) 1-13.

Carpenter, A., Gardner, K., Fopiano, J., Benson, C., and Edil, T. (2007), Life Cycle Based Risk Assessment of Recycled Materials in Roadway Construction, *Waste Mgmt.*, 27, 1458-1464.

Dingrando, J., Edil, T., and Benson, C. (2004), Beneficial Reuse of Foundry Sands in Controlled Low Strength Material, *J. ASTM Intl.*, 1(6), 1-12.

Ebrahimi, A., Kootstra, B., Edil, T., and Benson, C. (2012), Practical Approach for Designing Flexible Pavements Using Recycled Roadway Materials as Base Course, *Road Materials and Pavement Design*, 13(3), 1-18.

Edil, T., Acosta, H., and Benson, C. (2006), Stabilizing Soft Fine-Grained Soils with Fly Ash, *J. Materials in Civil Engineering*, 18(2), 283-294.

Edil, T., Benson, C., Bin-Shafique, M., Tanyu, B., Kim, W., and Senol, A. (2002), Field Evaluation of Construction Alternatives for Roadway Over Soft Subgrade, *J. Transportation Research Board*, 1786, 36-48.

Foose, G., Benson, C., and Bosscher, P. (1996), Sand Reinforced with Shredded Waste Tires, *J. Geotech. Eng.*, 122(9), 760-767.

Goodhue, M. Edil, T., and Benson, C. (2001), Interaction of Foundry Sands with Geosynthetics, *J. Geotech. Geoenvironmental Eng.*, 127(4), 353-362.

Komonweeraket, K., Cetin, B., Aydilek, A., Benson, C., Edil, T. (2014), Effects of pH on the Leaching Mechanisms of Elements from Fly Ash Mixed Soils, *Fuel*, American Chemical Society, 140, 788-802.

Komonweeraket, K., Cetin, B., Aydilek, A., Benson, C., and Edil, T. (2015), Geochemical Analysis of Leached Elements from Fly Ash Stabilized Soils, *J. Geotech. Geoenviron. Eng.*, 04015012.

Komonweeraket, K., Cetin, B., Aydilek, A., Benson, C., Edil, T. (2015), Leaching Characteristics of Toxic Constituents from Coal Fly Ash Mixed Soils under the Influence of pH, *Waste Management*, 38, 174-184.

Kleven, J., Edil, T., and Benson, C. (2000), Evaluation of Excess Foundry System Sands for Use as Subbase Material, *J. Transportation Research Board*, 1714, 40-48.

Lee, J., Edil, T., Benson, C., and Tinjum, J., (2013), Building Environmentally and Economically Sustainable Transportation Infrastructure: Green Highway Rating System, *J. Construction Engineering and Management*, 139(12), A4013006.

Lee, J., Bradshaw, S., Edil, T., and Benson, C (2012) Quantifying the Benefits of Flue Gas Desulfurization Gypsum in Sustainable Wallboard Production, *Coal Combustion and Gasification Products J.*, 4, 17-20.

Lee, J., Edil, T., Benson, C., and Tinjum, J., (2011), Evaluation of Variables Affecting Sustainable Highway Design with BE^{2}ST-in-Highways System, *J. Transportation Res. Board*, 2233, 178-186.

Lee, J., Edil, T., Tinjum, J., and Benson, C. (2010), Quantitative Assessment of Environmental and Economic Benefits of Using Recycled Construction Materials in Highway Construction, *J. Transportation Research Board*, 2158, 138-142.

Lee, T. and Benson, C. (2006), Leaching Behavior of Green Sands from Gray-Iron Foundries Used for Reactive Barrier Applications, *Environmental Engineering Science*, 23(1), 153-167.

Li, L., Benson, C., Edil, T., and Hatipoglu, B. (2007), Groundwater Impacts from Coal Ash in Highways, *Waste and Resource Management*, 159(4), 151-162.

Li, L., Benson, C., Edil, T., and Hatipoglu, B. (2008), Sustainable Construction Case History: Fly Ash Stabilization of Recycled Asphalt Pavement Material, *Geotechnical and Geological Engineering*, 26, 177-187.

Li, L., Edil, T., and Benson, C. (2009), Mechanical Performance of Pavement Geomaterials Stabilized with Fly Ash in Field Applications, *Coal Combustion and Gasification Products*, 1: 43-49, doi:10.4177/CCGP-D-09-00018.1.

Li, H. et al. (2022), Expanding Plastics Recycling Technologies: Chemical Aspects, Technology Status, and Challenges, *Green Chemistry*, https://doi.org/10.1039/D2GC02588D.

Liu, X., Wen, H., Edil, T., and Benson, C. (2010), Stabilization of Flue Gas Desulphurization By-Products with Fly Ash, Cement, and Sialite, *J. Transportation Research Board*, 2204, 102-109**.**

Ma, J. et al. (2023), Economic Evaluation of Infrastructures for Thermochemical Upcycling of Post-Consumer Plastic Waste, *Green Chemistry*, 2025, 3, https://doi.org/10.1039/d2gc04005k.

Olafasakin, O. et al. (2023), Techno-Economic and Life Cycle Assessment of Standalone Single-Stream Material Recovery Facilities in the United States, *Waste Management*, 166, 368–376.

Rosa, M., Cetin, B., Edil, T., and Benson, C. (2016), Development of a Test Procedure for Freeze-Thaw Durability of Geomaterials Stabilized with Fly Ash, *Geotech. Testing J.*, 39(6) 938-953.

Rosa, M., Cetin, B., Edil, T., and Benson, C. (2017), Freeze-Thaw Performance of Fly Ash Stabilized Materials and Recycled Pavement Materials, *J. Materials in Civil Engineering,* 04017015.

Sauer, J., Benson, C., Aydilek, A., and Edil, T. (2012), Trace Elements Leaching from Organic Soils Stabilized with High Carbon Fly Ash, *J. Geotech. Geoenvironmental Eng.*, 138(8), 968-980.

Senol, A., Edil, T., Bin-Shafique, S., Acosta, H., and Benson, C. (2006), Soft Subgrade Stabilization Using Fly Ashes, *Resources, Conservation and Recycling*, 46(4), 365-376.

Senol, A., Bin-Shafique, S., Edil, T., and Benson, C. (2003), Use of Class C Fly Ash for Stabilization of Soft Subgrade, ARI, *Bulletin Istanbul Technical University*, 53(1), 98-104.

Soleimanbeigi, A., Edil, T., and Benson, C. (2013), Evaluation of Fly Ash Stabilization of Recycled Asphalt Shingles for Use in Structural Fills, *J. Materials Civil Eng.*, 25(1), 94-104.

Soleimanbeigi, A., Edil, T., and Benson, C. (2014), Creep Response of Recycled Asphalt Shingles, *Canadian Geotechnical J.*, 51, 103-114.

Soleimanbeigi, A., Edil, T., and Benson, C. (2014), Effect of Temperature on Geotechnical Properties of Recycled Asphalt Shingle Mixtures, *J. Geotech. Geoenvironmental Eng.*, 04014097.

Tanyu, B., Kim, W., Edil, T., and Benson, C., (2006), Development of Methodology to Include Structural Contribution of Alternative Working Platforms in Pavement Structure, *J. Transportation Research Board*, 1936, 70-77.

Tanyu, B., Benson, C., Edil, T., and Kim, W. (2005), Equivalency of Crushed Rock and Three Industrial By-Products Used for Working Platforms During Pavement Construction, *J. Transportation Research Board*, 1874, 59-69.

Tastan, O., Edil, T., Benson, C., and Aydilek, A. (2011), Stabilization of Organic Soils with Fly Ash, *J. Geotech. Geoenvironmental Eng.*, 137(9), 819-833.

Tatlisoz, N., Edil, T., and Benson, C. (1998), Interaction between Reinforcing Geosynthetics and Soil-Tire Chip Mixtures, *J. Geotech. Geoenvironmental Eng.*, 124(11), 1109-1119.

Trzebiatowski, B. and Benson, C. (2005), Saturated Hydraulic Conductivity of Compacted Recycled Asphalt Pavement, *Geotech. Testing J.*, 28(5), 514-519.

Refereed Journal Articles: Groundwater

Alumbaugh, D., Simon, D. and Benson, C. (2005), Comparison of Three Geophysical Methods for Characterizing Air Flow from an Air Sparging Well, *Near Surface Geophysics*, *Part II: Applications and Case Histories*, Society of Exploration Geophysicists, 20, 1-12.

Baker, D. and Benson, C. (2007), Effect of System Variables and Particle Size on Physical Characteristics of Air Sparging Plumes, *Geotechnical and Geological Engineering*, 25(5), 543-558.

Benson, C., Jo, H., and Musso, T. (2014), Hydraulic Conductivity of an Organoclay and Organoclay-Sand Mixtures to Fuels and Organic Liquids, *J. Geotech. Geoenviron. Eng.*, 125(11), 04014094.

Christman, M., Benson, C., and Edil, T. (2002), Geophysical Evaluation of Annular Well Seals, *Ground Water Monitoring and Remediation*, 22(3), 104-112.

Cope, D. and Benson, C. (2009), Grey-Iron Foundry Slags as Reactive Media for Removing Trichloroethylene from Groundwater, *Environ. Science & Technology*, 43(1), 169-175.

Elder, C. and Benson, C. (2019), Performance and Economic Comparison of PRB Types in Heterogeneous Aquifers, *Environmental Geotechnics*, 6(4), 214-224.

Elder, C., Benson, C., and Eykholt, G. (2002), Effects of Heterogeneity on Influent and Effluent Concentrations from Horizontal Permeable Reactive Barriers, *Water Resources Research*, 38(8), 27-1 to 27-2.

Elder, C. and Benson, C., and Eykholt, G. (1999), Modeling Mass Removal During In Situ Air Sparging, *J. Geotech. Geoenvironmental Eng.*, 125(11), 947-958.

Elder, C. and Benson, C. (1999), Air Channel Formation, Size, Spacing, and Tortuosity During Air Sparging, *Ground Water Monitoring and Remediation*, 19(3), 171-181.

Eykholt, G., Elder, C., and Benson, C. (1999), Effects of Aquifer Heterogeneity and Reaction Mechanisms Uncertainty on a Reactive Barrier, *J. Hazardous Materials*, 68, 73-96.

Foose, G., Tachavises, C., Benson, C., and Edil, T. (1998), Analyzing Geoenvironmental Engineering Problems Using MODFLOW, *Naresuan University J.*, Thailand, 6(2), 38-44.

Lee, S., Oren, A., Benson, C., and Dovantzis, K. (2012), Organoclays as Variably Permeable Reactive Barrier (VPRB) Media to Manage NAPLs in Ground Water, *J. Geotech. Geoenvironmental Eng.*, 138(2), 115-127.

Lee, T. and Benson, C. (2004), Sorption and Degradation of Alachlor and Metolachlor in Ground Water Using Green Sands, *J. Environmental Quality*, 33(5), 1682-1693.

Lee, T., Benson, C., and Eykholt, G. (2004), Waste Green Sands as Reactive Media for Groundwater Contaminated with Trichloroethylene, *J. Hazardous Materials*, 109 (1-3), 25-36.

Lee, T. and Benson, C. (2000), Flow Paste Bench-Scale Vertical Groundwater Cut-Off Walls, *J. Geotech. Geoenvironmental Eng.*, 126(6) 511-520.

Li, L. and Benson, C. (2010), Evaluation of Five Strategies to Limit the Impact of Fouling in Permeable Reactive Barriers, *J. Hazardous Materials*, 181, 170-180.

Li, L., Benson, C., and Lawson, E. (2006), Modeling Porosity Reductions Caused by Mineral Fouling in Continuous-Wall Permeable Reactive Barriers, *J. Contaminant Hydrology*, 83 (1-2), 89-121.

Li, L., Benson, C., and Lawson, E. (2005), Impact of Mineral Fouling on Hydraulic Behavior of Permeable Reactive Barriers, *Ground Water*, 43(4), 582-596.

Pekarun, O., Benson, C., and Edil, T. (1997), Significance of Defects in Annular Well Seals, *Practice Periodical Hazardous, Toxic, and Radioactive Waste*, 2(2) 1-7.

Tinjum, J., Benson, C., and Edil, T. (2008), Mobilization of Cr(VI) from Chromite Ore Processing Residue through Acid Treatment, *Science of the Total Environment*, 391, 13-25.

Tinjum, J., Benson, C., and Edil, T. (2008), Treatment of Cr(VI) in Chromium Ore Processing Residue Using Ferrous Sulfate-Sulfuric Acid or Cationic Polysulfides, *J. Geotech. Geoenvironmental Eng.*, 134(12), 1791-1803.

Yesiller, N., Benson, C., and Edil, T. (1997), Field Evaluation of an Ultrasonic Method for Assessing Well Seals, *Ground Water Monitoring and Remediation*, 17(3), 169-177.

Yesiller, N., Edil, T., and Benson, C. (1997), Ultrasonic Method for Evaluation of Annular Seals for Wells and Instrument Holes, *Geotech. Testing J.*, 20(1), 17-28.

Refereed Journal Articles: Other Topics

Albrecht, B., Benson, C., and Beuermann, S. (2003), Polymer Capacitance Sensors for Measuring Soil Gas Humidity in Drier Soils, *Geotech. Testing J.*, 26(1) 3-12.

Bareither, C. and Benson, C. (2013), Evaluation of Bouwer-Rice Large-Particle Correction Procedure for Soil Water Characteristic Curves, *Geotechnical Testing J.*, 36(5), 680-694.

Bareither, C., Benson, C., and Edil, T. (2008), Reproducibility of Direct Shear Tests Conducted on Granular Backfill Materials, *Geotechnical Testing J.*, 31(1) 1-11.

Bareither, C., Benson, C., and Edil, T. (2008), Comparison of Shear Strength of Sand Backfills Measured in Small-Scale and Large-Scale Direct Shear Tests, *Canadian Geotechnical J.*, 45, 1242-1236.

Bareither, C., Edil, T., Benson, C., and Mickelson, D. (2008), Geological and Physical Factors Affecting the Friction Angle of Compacted Sands, *J. Geotech. Geoenvironmental Eng.*, 134(10), 1476-1489.

Bareither, C., Barlaz, M., Doran, M., and Benson, C. (2016), Retrospective Analysis of Wisconsin's Landfill Organic Stability Rule, *J. Environmental Engineering*, 143(5), 04017001.

Camargo, F., Edil, T., and Benson, C. (2012), An Assessment of Resilient Modulus Testing: Internal and External Deflection Measurements, *Geotechnical Testing J.*, 35(6), 1-8.

Chalermyanont, T. and Benson, C. (2005), Reliability Based Design for External Stability of Mechanically Stabilized Earth (MSE) Walls, *Intl. J. Geomechanics*, 5(3), 196-205.

Chalermyanont, T. and Benson, C. (2004), Reliability-Based Design for Internal Stability of Mechanically Stabilized Earth (MSE) Walls, *J. Geotech. Geoenvironmental Eng.*, 130(2), 163-173.

Fall, M., Sawangsuriya, A., Benson, C., Edil, T., and Bosscher, P. (2008), On the Investigations of Resilient Modulus of Residual Tropical Gravel Lateritic Soils from Senegal (West Africa), *Geotechnical and Geological Engineering*, 26, 13-35.

Jong, D., Bosscher, P., and Benson, C. (1998), Field Assessment of Changes in Pavement Moduli Caused by Freezing and Thawing, *J. Transportation Research Board*, 1615, 41-50.

Kanitpong, K., Benson, C., and Bahia, H. (2001), Hydraulic Conductivity (Permeability) of Laboratory-Compacted Asphalt Mixtures, *J. Transportation Research Board*, 1767, 25-33.

Kim, W., Edil, T., Benson, C., and Tanyu, B., (2006), Deflection of Prototype Geosynthetic-Reinforced Working Platforms Over Soft Subgrade, *J. Transportation Research Board*, 1975, 137-145.

Kim, W., Edil, T., Benson, C., and Tanyu, B., (2005), Structural Contribution Geosynthetic-Reinforced Working Platforms in Flexible Pavement, *J. Trans. Research Board*, 1936, 43-50.

Mengelt, M., Edil, T., and Benson, C. (2006), Resilient Modulus and Plastic Deformation of Soil Confined in a Geocell, *Geosynthetics Intl.*, 13(5), 1-11.

Rosa, M., Cetin, B., Edil, T., and Benson, C. (2016), Development of a Test Procedure for Freeze-Thaw Durability of Geomaterials Stabilized with Fly Ash, *Geotech. Testing J.*, 39(6), 938-953.

Russell, J., Benson C., and Fox, P. (1990), A Stochastic Decision Model for Contractor Prequalification, *Microcomputers in Civil Engineering*, 5(4), 285-297.

Sawangsuriya, A., Edil, T., and Benson, C. (2008), Effect of Suction on the Resilient Modulus of Compacted Fine-Grained Subgrade Soils, *J. Transportation Research Board*, 2101, 82-87.

Suwansawat, S. and Benson, C. (1998), Cell Size for Water Content-Dielectric Constant Calibrations for Time Domain Reflectometry, *Geotechnical Testing J*., 22(1), 3-12.

Tanyu, B., Aydilek, A., Lau, A., Edil, T., and Benson, C. (2013) Laboratory Evaluation of Geocell-Reinforced Gravel Subbase Over Poor Subgrades, *Geosynthetics Intl*., 20(2), 47-61. **(Editor's Choice)**.

Yesiller, N., Benson, C., and Bosscher, P. (1996), Comparison of Load Restriction Timings Determined Using FHWA Guidelines and Frost Tubes, *J. Cold Regions Eng*., 10(1), 6-24.

Wainwright, H. et al. (2023), Nuclear Waste Educator's Workshop: What and How Do We Teach About Nuclear Waste?, *J. Environmental Radioactivity*, 270, 107288.

Wang, X. and Benson, C. (2004), Leak-Free Pressure Plate Extractor for Measuring the Soil Water Characteristic Curve, *Geotech. Testing J*., 27(2), 1-10.

Discussions

Barlaz, M., Benson, C., Castaldi, M., and Luettich, S. (2018), Comment on "Spatial and Temporal Characteristics of Elevated Temperatures in Municipal Solid Waste Landfills," by N. Jafari, T. Stark, and T. Thalhamer, *Waste Management*, 71, 244-245.

Benson, C. and Edil, T. (2004) Comment on "A Polymer Membrane Containing Fe0 as a Contaminant Barrier" by T. Shimitori et al., *Environ. Science and Tech*., 38(19), 5263.

Refereed Conference Papers

Abichou, T., Edil, T., Benson, C., and Tawfiq, K. (2004), Hydraulic Conductivity of Foundry Sands and Their Use as Hydraulic Barriers, *Beneficial Reuse of Waste Materials in Geotechnical and Transportation Applications*, GSP No. 127, A. Aydilek and J. Wartman, eds., ASCE, Reston, VA, 186-200.

Abichou, T., Tawfiq, K., Edil, T., and Benson, C., (2004), Behavior of a Soil-Tire Shreds Backfill for Modular Block Wall, *Beneficial Reuse of Waste Materials in Geotechnical and Transportation Applications*, GSP No. 127, A. Aydilek and J. Wartman, eds., ASCE, Reston, VA, 162-172.

Abichou, T., Benson, C., Friend, M., and Wang, X. (2002), Hydraulic Conductivity of a Fractured Aquitard, *Evaluation and Remediation of Low Permeability and Dual Porosity Environments*, STP 1415, M. Sara and L. Everett, Eds., ASTM International, West Conshohocken, PA, 25-39.

Abichou, T., Benson, C., and Edil, T. (1998), Database on Beneficial Reuse of Foundry By-Products, *Recycled Materials in Geotechnical Applications*, GSP No. 79, ASCE, C. Vipulanandan and D. Elton, eds., 210-224.

Abichou, T., Benson, C., Edil, T., and Freber, B. (1998), Using Waste Foundry Sand for Hydraulic Barriers, *Recycled Materials in Geotechnical Applications*, GSP No. 79, ASCE, C. Vipulanandan and D. Elton, eds., 86-99.

Akin, I., Chen, J., Benson, C., and Likos, W. (2018), Evaluation of Water Vapor Sorption and Electrical Conductivity Methods to Determine Bentonite Content of a Soil-Bentonite Barrier, *Proc.* IFCEE 2018, Developments in Earth Retention, Support Systems, and Tunneling, *GSP No. 297*, ASCE, Lemnitzer, A., Stuedlein, A., and Suleiman, M., eds., 238-246.

Akin, I., Chen, J., Likos, W., and Benson, C. (2017), Water Vapor Sorption of Bentonite-Polymer Mixtures Contacted with Aggressive Leachates, *Geotechnical Frontiers 2017, Waste Containment, Barriers, Remediation, and Sustainable Geoengineering, GSP No. 276*, ASCE, T. Brandon and R. Valentine, eds., 210-218.

Albright, W., Scalia, J., Benson, C., and Smith, B. (2014), Effects of Age and Differential Settlement on Composite Barrier Components in a Landfill Final Cover, *Proceedings Waste Management '14*, WM Symposia Inc., Phoenix, AZ, 1-10. (**Best Paper Award**)

Athanassopoulos, C., Benson, C., Chen, J., and Donovan, M. (2015), Hydraulic Conductivity of a Polymer-Modified GCL Permeated with High-pH Solutions, *Geosynthetics 2015*, IFAI, St. Paul, MN, 181-186.

Apiwantragoon, P., Benson, C., and Albright, W. (2003), Comparison of Water Balance Predictions Made with HYDRUS-2D and Field Data from the Alternative Cover Assessment Program (ACAP), *Proc. MODFLOW and More 2003: Understanding through Modeling*, International Groundwater Modeling Center, Golden, CO, 751-755.

Apiwantragoon, P. and Benson, C. (2025), Water Balance Landfill Covers: Hydraulic Performance and Equivalency, *Geoenvironmental Engineering*, GSP No. 362, M. Othman and N. Yesiller, eds., ASCE, Reston, VA, 145-168.

Baker, D. and Benson, C. (1996), Review of Factors Affecting In Situ Air Sparging, *Non-Aqueous Phase Liquids in Subsurface Remediation*, ASCE, L. Reddi, ed., 292-310.

Bareither, C., Benson, C., and Edil, T. (2012), Recent Findings on Compressibility of Municipal Solid Waste, *State of the Art and Practice in Geotechnical Engineering, GSP No. 225*, R. Hryciw et al., Eds., ASCE, Reston VA, 4212-4221.

Bareither, C., Breitmeyer, R., Erses, A., Benson, C., Edil, T., and Barlaz, M. (2008), Relative Contributions of Moisture and Biological Activity on Compression of Municipal Solid Waste in Bioreactor Landfills, *Proceedings, Global Waste Management Symposium 2008*, Penton Media, Orlando, 1-9.

Bareither, C., Edil, T., and Benson, C (2012), Investigation of White Bluffs Landslides in Washington State, *State of the Art and Practice in Geotechnical Engineering, GSP No. 225*, R. Hryciw et al., eds., ASCE, Reston VA, 546-555.

Benson, C., Albright, W., Apiwantragoon, P., and Lyles, B. (2022), Hydrology of Final Covers for Overburden Piles and Pit Backfill at High Elevation Mine Sites in Southeastern Idaho, *Proc. Tailings and Mine Waste*, Colorado State University, 1-12.

Benson, C. (2017), Using Principles of Unsaturated Soil Behavior to Design Water Balance Covers for Waste Containment: Case Study, *Proc. PanAm Unsaturated Soils 2017, Plenary Papers, GSP No. 300*, L. Hoyos, J. McCartney, S. Houston, and W. Likos, eds., ASCE, Reston VA, 306-324.

Benson, C. (2017), Characteristics of Gas and Leachate at an Elevated Temperature Landfill, *Geotechnical Frontiers 2017, Waste Containment, Barriers, Remediation, and Sustainable Geoengineering, GSP No. 276*, ASCE, T. Brandon and R. Valentine, eds., 313-322.

Benson, C. (2013), Impact of Subgrade Water Content on Cation Exchange and Hydraulic Conductivity of Geosynthetic Clay Liners in Composite Barriers, in *Coupled Phenomena in Environmental Geotechnics*, M. Manassero et al., eds., CRC Press, Boca Raton, FL, USA, 1-6.

Benson, C., Albright, W., Fuhrmann, M., Likos, W., Stefani, N., Tian, K, Waugh, W., and Williams, M. (2017), Radon Fluxes from an Earthen Barrier Over Uranium Mill Tailings After Two Decades of Service, *Proceedings Waste Management '17*, WM Symposia Inc., Phoenix, AZ, 1-10.

Benson, C., Chen, J., and Tian, K. (2021), Stress-Induced Pore Water Pressures in the Vadose Zone Beneath a Composite Lined Landfill, *Third International Symposium on Coupled Phenomena in Environmental Geotechnics*, Japanese Geotechnical Society Special Publication, Vol. 9, Japanese Geotechnical Society, Tokyo, 478-484.

Benson, C., Chiang, I., Chalermyanont, T., and Sawangsuriya, A. (2014), Estimating van Genuchten Parameters α and n for Clean Sands from Particle Size Distribution Data, *From Soil Behavior to Innovations in Geotechnical Engineering, GSP No. 233*, M. Iskander, J. Garlanger, and M. Hussein, Eds., ASCE, Reston VA, 410-427.

Benson, C. and Gurdal, T. (2013), Hydrologic Properties of Final Cover Soils, Foundation Engineering in the Face of Uncertainty, *GSP No. 229*, J. Withiam et al., Eds., ASCE, Reston VA, 283-297.

Benson, C. and Bareither, C. (2012), Designing Water Balance Covers for Sustainable Waste Containment: Transitioning State-of-the-Art to State-of-the-Practice, *State of the Art and Practice in Geotechnical Engineering, Keynote Lectures from GeoCongress 2012, GSP No. 226,* K. Rollins and D. Zekkos, eds., ASCE, Reston VA, 1-32.

Benson, C., Tan, Y., Youngblood, J., and Bradshaw, S. (2022), Bentonite-Polymer Composite Geosynthetic Clay Liners for Heap Leach Liners, *Proc. 5th International Conference on Heap Leach Mining Solutions 2022*, C3 Alliance, Vancouver, 13-25.

Benson, C., Tan, Y., Youngblood, J., and Bradshaw, S. (2023), Effect of Initial Stress on Hydraulic Conductivity of Bentonite-Polymer Composite Geosynthetic Clay Liners for Heap Leach Liners, *Geosynthetics 2023*, Advanced Textiles Association, Rosemont, MN, 592-603.

Benson, C. and Tian, K. (2019), Stress-Induced Porewater Pressures in the Vadose Zone Beneath a Mixed Waste Landfill, *Proc. Waste Management '19*, WM Symposia Inc., Phoenix, AZ (**Superior Paper Award**).

Benson, C., Waugh, W., Albright, W., Smith, G., and Bush, R. (2011), Design and Installation of a Disposal Cell Cover Field Test, *Proc. Waste Management '11*, WM Symposia Inc., Phoenix, AZ.

Benson, C. and Bareither, C. (2010), Bioreactor Landfills: Lessons Learned in North America, *Proc. Sixth Asian-Pacific Landfill Symposium*, Korean Society of Waste Management, Seoul, 54-72.

Benson, C. (2010), Predictions in Geoenvironmental Engineering: Recommendations for Reliable Predictive Modeling, *GeoFlorida 2010, Advances in Analysis, Modeling, and Design*, Geotechnical Special Publication No. 199, D. Fratta, A. Puppula, and B. Muhunthan, eds., ASCE, Reston, VA, 1-13.

Benson, C. and Scalia, J. (2010), Hydraulic Conductivity of Exhumed Geosynthetic Clay Liners from Composite Barriers, *Proc. 3rd Intl. Symposium on Geosynthetic Clay Liners*, SKZ – ConSem GmbH, Wurzburg, Germany, 73-82.

Benson, C., Wang, X., Gassner, F., and Foo, D. (2008), Hydraulic Conductivity of Two Geosynthetic Clay Liners Permeated with an Aluminum Residue Leachate, *GeoAmericas 2008*, International Geosynthetics Society.

Benson, C. Albright, W., Ray, D., Smegal, J., Robertson, O, and Gupta, D. (2008). Evaluating Operational Irregularities at Hanford's Environmental Restoration Disposal Facility, *Proc. Waste Management '08*, WM Symposia Inc., Phoenix, AZ.

Benson, C. (2007), Modeling Unsaturated Flow and Atmospheric Interactions, *Theoretical and Numerical Unsaturated Soil Mechanics*, T. Schanz, Ed., Springer, Berlin, 187-202.

Benson, C. and Wang, X. (2006), Temperature-Compensating Calibration Procedure for Water Content Reflectometers, *Proceedings TDR 2006: 3rd Intl. Symposium and Workshop on Time Domain Reflectometry for Innovative Soils Applications,* Purdue University, West Lafayette, IN, USA, 50-1 - 5-16.

Benson, C., Bohnhoff, G., Ogorzalek, A., Shackelford, C., Apiwantragoon, P., and Albright, W. (2005), Field Data and Model Predictions for an Alternative Cover, *Waste Containment and Remediation*, GSP No. 142, A. Alshawabkeh et al., eds., ASCE, Reston, VA, 1-12.

Benson, C., Tipton, R., Kumthekar, U., and Chiou, J. (2003), Web-Based Data Management System for Long-Term Performance Monitoring and Stewardship of a Low-Level Radioactive Waste Disposal Facility, *Proc. Ninth Intl. Conference on Radioactive Waste Management and Environmental Remediation*, ASME, S16, 1-6.

Benson, C. and Chen, C. (2003), Selecting the Thickness of Monolithic Earthen Covers for Waste Containment, *Soil and Rock America 2003*, Verlag Gluck auf GMBH, Germany, 1397-1404.

Benson, C. (2002), Containment Systems: Lessons Learned from North American Failures, *Environmental Geotechnics (4th ICEG)*, Swets and Zeitlinger, Lisse, 1095-1112.

Benson, C., Albright, W., Roesler, A., and Abichou, T. (2002), Evaluation of Final Cover Performance: Field Data from the Alternative Cover Assessment Program (ACAP), *Proc. Waste Management '02*, WM Symposia Inc., Tucson, AZ.

Benson, C. (2001), Waste Containment: Strategies & Performance, *Proc. Geoenvironment 2001*, Australia-New Zealand Geomechanics Society, D. Smith, S. Fytus, & M. Allman, eds., 23-52.

Benson, C. and Boutwell, G. (2000), Compaction Conditions and Scale-Dependent Hydraulic Conductivity of Compacted Clay Liners, *Constructing and Controlling Compaction of Earth Fills, ASTM STP 1384,* D. Shanklin, K. Rademacher, and J. Talbot, Eds., ASTM, 254-273.

Benson, C. and Wang, X. (2000), Hydraulic Conductivity Assessment of Hydraulic Barriers Constructed with Paper Sludge, *Geotechnics of High Water Content Materials,* STP 1374, ASTM, T. Edil and P. Fox, Eds., 91-107.

Benson, C. and Bosscher, P. (1999), Remote Field Methods to Measure Frost Depth, *Field Instrumentation for Soil and Rock,* STP 1358, ASTM, G. Durham and W. Marr, Eds., 267-284.

Benson, C. and Bosscher, P. (1999), Time-Domain Reflectometry in Geotechnics: A Review, *Nondestructive and Automated Testing for Soil and Rock Properties*, STP 1350, ASTM, W. Marr and C. Fairhurst, Eds., 113-136.

Benson, C. and Gribb, M. (1997), Measuring Unsaturated Hydraulic Conductivity in the Laboratory and Field, *Unsaturated Soil Engineering Practice*, GSP No. 68, ASCE, S. Houston and D. Fredlund, eds., 113-168.

Benson, C. and Khire, M. (1995), Earthen Covers for Semi-Arid and Arid Climates, *Landfill Closures*, ASCE, GSP No. 53, J. Dunn and U. Singh, eds., 201-217.

Benson, C., Tinjum, J., and Hussin, C. (1995), Leakage Rates Through Geomembranes Containing Holes, *Geosynthetics 95*, Industrial Fabrics Assoc. Intl., St. Paul 745-758.

Benson, C., Hardianto, F., and Motan, E. (1994), Representative Specimen Size for Hydraulic Conductivity of Compacted Soil Liners, *Hydraulic Conductivity and Waste Contaminant Transport in Soils, STP 1142*, ASTM, S. Trautwein and D. Daniel, eds., 3-29.

Benson, C. and Khire, M. (1993), Soil Reinforcement with Strips of Reclaimed HDPE, *Geosynthetics 93*, Industrial Fabrics Assoc. Intl., St. Paul, 935-948.

Benson, C. and Charbeneau, R. (1991), Reliability Analysis for Time of Travel in Compacted Soil Liners, *Geotechnical Congress 1991*, ASCE, GSP No. 27, 456-467.

Bergstrom, W., Creamer, P., Petrusha, H., and Benson, C. (1994), Field Performance of a Double Liner Test Pad, *Geoenvironment 2000*, GSP No. 46, ASCE, 608-623.

Bosscher, P., Jong, D., and Benson, C. (1998), Software to Establish Seasonal Load Limits for Flexible Pavements, *Cold Regions Impact on Civil Works*, D. Newcomb, ed., ASCE, 731-747.

Bozyurt, O., Tinjum, J., Son, Y., Edil, T., and Benson, C (2012), Resilient Modulus of Recycled Asphalt Pavement and Recycled Concrete Aggregate, *State of the Art and Practice in Geotechnical Engineering, GSP No. 225,* R. Hryciw et al., Eds., ASCE, Reston VA, 3901-3910.

Bradshaw, S., Benson, C., Olenbush, E., and Melton, J. (2010), Using Foundry Sand in Green Infrastructure Construction, *Proc. Green Streets and Highways 2010*, ASCE, 280-298.

Bradshaw, S., Edil, T., and Benson, C. (2025), Greenhouse Gas Impacts of Harvesting Coal Ash for Cement Replacement in Concrete, *Geoenvironmental Engineering*, GSP No. 362, M. Othman and N. Yesiller, eds., ASCE, Reston, VA, 53-67.

Breitmeyer, R., Bareither, C., Benson, C., Edil, T., and Barlaz, M. (2008), Field-Scale Lysimeter Experiment to Study Hydrologic and Mechanical Properties of Municipal Solid Waste, *Proceedings, Global Waste Management Symposium 2008*, Penton Media, Orlando, 1-11.

Breitmeyer, R. and Benson, C. (2011), Measurement of Unsaturated Hydraulic Properties of Municipal Solid Waste, *GeoFrontiers 2011 Advances in Geotechnical Engineering*, GSP No. 211, J. Han and D. Alazamora, eds., ASCE, Reston, VA, 1433-1442.

Brown, B., Benson, C., Edil, T., and Bradshaw, S. (2016), Water Quality Risk Assessment from Roadway Substructures Employing Fly Ash, *Proc. Geo-Chicago 2016: Sustainable Geoenvironmental Systems*, ASCE, GSP 271, A. De, K. Reddy, N. Yesiller, D. Zekkos, and A. Farid, eds., 998-1008.

Chalermyanont, T. and Benson, C. (2005), Method to Estimate the System Probability of Failure of Mechanically Stabilized Earth (MSE) Walls, *Slopes and Retaining Structures Under Seismic and Static Conditions*, GSP No. 140, M. Gabr et al., eds., ASCE, Reston, VA, 1-15.

Chamberlain, E., Erickson, A. and Benson, C. (1994), Effects of Frost Action on Compacted Clay Barriers, *Geoenvironment 2000*, ASCE, GSP No. 46, 702-717.

Chen, J., Chen, Z., Gruber, C., Brown, K., Kosson, D., and Benson, C. (2024), Modeling Pre- and Post-Closure Hydrological Conditions of Waste Tanks at the Hanford Sites, Washington, *Proc. Waste Management 2024*, WM Symposia Inc., 24058, 1-8.

Chen, J. and Benson, C. (2023), Hydrological Evaluation of Placement Strategies for Disposal of Cementitious Waste Forms, *Proc. Waste Management 2023*, WM Symposia Inc., 23045, 1-14.

Chen, J. and Benson, C. (2022), Using Hydrological Modeling and Particle Tracking to Identify Monitoring Well Locations Near a LLW Disposal Facility, *Proc. Waste Management 2022*, WM Symposia Inc., 22084, 1-5.

Chen, J. and Benson, C. (2021), Using Perimeter Subsurface Drains to Control Groundwater Levels Beneath Low-level and Mixed Waste Landfills, *Proc. Waste Management '21*, WM Symposia Inc., Phoenix, AZ. **(Superior Paper Award)**

Chen, J., Benson, C., and Tian, K. (2020), Modeling Stress-Induced Pore Water Pressures in The Vadose Zone Beneath a Composite-Lined Landfill, *Proc. Waste Management '20*, WM Symposia Inc., Phoenix, AZ.

Chen, J., Benson, C., Likos, W., and Edil, T. (2017), Interface Shear Strength of a Bentonite-Polymer Geosynthetic Clay Liner and a Textured Geomembrane, *Geotechnical Frontiers 2017, Waste Containment, Barriers, Remediation, and Sustainable Geoengineering*, *GSP No. 276*, ASCE, T. Brandon and R. Valentine, eds., 219-225.

Chen, J., Benson, C., and Edil, T. (2015), Hydraulic Conductivity of Geosynthetic Clay Liners to Coal Combustion Product Leachates, *Geosynthetics 2015*, IFAI, St. Paul, MN, 173-180.

Chen, J., Benson, C., and Tian, K. (2018), Hydraulic Conductivity of Bentonite-Polymer Geosynthetic Clay Liners to Coal Combustion Product Leachates, *Proc. 8th Intl. Conference on Environmental Geotechnics*, Springer Nature, Singapore, L. Zhan et al. (Eds.): 664–671, https://doi.org/10.1007/978-981-13-2224-2_82.

Chen, J., Bradshaw, S., Benson, C., Tinjum, J., and Edil, T. (2012), pH-Dependent Leaching of Trace Elements from Recycled Concrete Aggregate, *State of the Art and Practice in Geotechnical Engineering, GSP No. 225*, R. Hryciw et al., Eds., ASCE, Reston VA, 3729-3738.

Chen, J., Bradshaw, S., Likos, W., Benson, C., and Edil, T. (2014), Hydraulic Conductivity of Geosynthetic Clay Liners to Synthetic Coal Combustion Product Leachates, Geo-Characterization and Modeling for Sustainability, *Geotechnical Special Publication No. 234*, ASCE, Reston, VA, 334-342.

Chen, J., Gustitus, S., and Benson, C. (2021), Hydraulic Conductivity of Bentonite-Polymer Composite Geosynthetic Clay Liners Permeated with Bauxite Liquor, *Proc. Geosynthetics 2021*, Industrial Fabrics Association International, St. Paul, MN, 254-260.

Chen, J., Gustitus, S., and Benson, C. (2021), Effect of Polymer Elution on Interface Strength Between Bentonite-Polymer Geosynthetic Clay Liners and Geomembranes, *Third International Symposium on Coupled Phenomena in Environmental Geotechnics*, Japanese Geotechnical Society Special Publication, Vol. 9, Japanese Geotechnical Society, Tokyo, 45-48.

Chen, J., Gustitus, S., and Benson, C. (2021), Using Bentonite-Polymer Composite Geosynthetic Clay Liners to Contain Coal Combustion Product Leachates, *Proc. Geosynthetics 2021*, Industrial Fabrics Association International, St. Paul, MN, 274-281.

Davis, M., Benson, C., and Roberts, H. (2017), Constructing a Cover Performance Test Section on a Uranium Mill Tailings Management Cell, *Proc. Tailings and Mine Waste*, University of Alberta, 365-376.

Demirkanli, I., Bence, R., Rockhold, M., Johnson, C., Mangel, A., Morse, M., Holbrook, D., Benson, C., and Denny, A. (2024), Soil Water Balance Model Selection and Benchmark Tests for Evaluating Uranium Mill Tailings Disposal Cell Evapotranspiration Covers, *Proc. Waste Management 2024*, WM Symposia Inc., 24624, 1-15. **(Superior Paper Award)**

Dingrando, J., Edil, T., and Benson, C. (2004), Beneficial Reuse of Foundry Sands in Controlled Low Strength Material, *Innovations in Controlled Low-Strength Material (Flowable Fill),* STP 1459, J. Hitch, A. Howard, and W. Bass, eds., ASTM, West Conshohocken, PA.

Edil, T. and Benson, C. (1998), Geotechnics of Industrial Byproducts, *Recycled Materials in Geotechnical Applications*, GSP No. 79, ASCE, C. Vipulanandan and D. Elton, eds., 1-18.

Elder, C., Benson, C., and Eykholt, G. (1997), A Model for Predicting Mass Removal During Air Sparging, *In Situ Remediation of the Geoenvironment*, GSP No. 71, J. Evans, ed., ASCE, Reston, VA, 83-97.

Eun, J., Yilmaz, M., Tinjum, T., and Benson, C. (2017), Temperature Effect on the Transport of VOCs in a Co-extruded EVOH Geomembrane, *Geotechnical Frontiers 2017, Waste Containment, Barriers, Remediation, and Sustainable Geoengineering*, *GSP No. 276*, ASCE, T. Brandon and R. Valentine, eds., 302-312.

Eun, J., Yilmaz, M., Tinjum, J., and Benson, C. (2016), Hydrogen Sulfide Transport Through Simulated Interim Covers with Conventional and Co-Extruded Ethylene-Vinyl Alcohol Geomembranes, *Proc. Geo-Chicago 2016: Sustainable Geoenvironmental Systems*, ASCE, GSP 271, A. De, K. Reddy, N. Yesiller, D. Zekkos, and A. Farid, eds., 51-61.

Foose, G., Benson, C., and Edil, T. (1999), Equivalency of Composite Geosynthetic Clay Liners as a Barrier to Volatile Organic Compounds, *Geosynthetics 99*, Industrial Fabrics Association International, St. Paul, MN, 321-334.

Foose, G., Benson, C., and Edil, T. (1996), Evaluating the Effectiveness of Landfill Liners, *Proc. 2nd Intl. Conference on Environmental Geotechnics*, Osaka, Japan, 217-221.

Geng, W., Likos, W., Benson, C. (2016), Viscosity of Polymer-Modified Bentonite as a Hydraulic Performance Index, *Proc. Geo-Chicago 2016: Sustainable Geoenvironmental Systems*, ASCE, GSP 271, A. De, K. Reddy, N. Yesiller, D. Zekkos, and A. Farid, eds., 498-508.

Gustitus, S. and Benson, C. (2020), Assessing Polymer Elution and Hydraulic Conductivity of Bentonite-Polymer Composite Geosynthetic Clay Liners Permeated with Aggressive Solutions, *Proc. GeoAmericas 2020,* April 26-29, 2020, Rio De Janeiro, Brazil.

Gustitus, S. and Benson, C. (2021), Flow-Swell Index as an Indicator of Chemical Compatibility of Bentonite-Polymer Composite Geosynthetic Clay Liners, *Proc. Geosynthetics 2021*, Industrial Fabrics Association International, St. Paul, MN, 282-292.

Gustitus, S. and Benson, C. (2023), Hydraulic Conductivity of Bentonite-Polymer Composite Geosynthetic Clay Liners Under Elevated Temperature and Extreme pH, *Proc. Geosynthetics 2023*, Advanced Textiles Association, Rosemont, MN, 549-560.

Hou, J., Gustitus, S., and Benson, C. (2022), Pore-Scale Modeling of Polymer Clogging in Bentonite-Polymer Composite Geosynthetic Clay Liners, *Geo-Congress 2022, Soil Improvement, Geosynthetics, and Innovative Geomaterials,* ASCE, GSP No. 331, A. Lemnitzer and A. Stuedlein, eds., 597-604.

Hou, J., Xing, X., and Benson, C. (2023), Thermo-Hydro-Mechanical Shear Behavior of Interfaces Between a Textured Geomembrane and Geosynthetic Clay Liner, *Geo-Congress 2023*, *Foundations,* *Retaining Structures, and Geosynthetics*, ASCE, GSP No. 341, E. Rathje, B. Montoya, and M. Wayne, eds., 545-553.

Hou, J., Chu, C., and Benson, C. (2024), Evaluating the Impact of Bentonite Granule Size Distribution and Swelling on the Hydraulic Conductivity of Geosynthetic Clay Liners, *Proc. GeoAmericas 2024*, E3S Web of Conferences, 569, 14003, 11 p.

Hunter, E., Tinjum, J., and Benson, C. (2014), Radionuclide Behavior in Low-Level Radioactive Waste (LLW) Disposal Barrier Materials: Impacts of Sorption, *Geo-Congress 2014, Geo-Characterization and Modeling for Sustainability*, ASCE, GSP No. 234, M. Abu-Farsakh, X. Yu, Ph.D., and L. Hoyos, eds., 1929-1930.

Khire, M., Benson, C., and Bosscher, P. (1997), Water Balance of Two Earthen Landfill Caps in a Semi-Arid Climate, *Intl. Containment Tech.*, 252-261.

Khire, M., Meerdink, J., Benson, C., and Bosscher, P. (1995), Unsaturated Hydraulic Conductivity and Water Balance Predictions for Earthen Landfill Final Covers, *Soil Suction Applications in Geotechnical Engineering Practice*, ASCE, GSP No. 48, W. Wray and S. Houston, eds., 38-57.

Komonweeraket, K., Benson, C., Edil, T., and Bleam, W. (2011), Leaching Behavior and Mechanisms Controlling the Release of Elements from Soil Stabilized with Fly Ash, *GeoFrontiers 2011 Advances in Geotechnical Engineering*, GSP No. 211, J. Han and D. Alazamora, eds., ASCE, Reston, VA, 1101-1110.

Kootstra, B., Ebrahimi, A., Edil, T., and Benson, C. (2010), Plastic Deformation of Recycled Base Materials, *GeoFlorida 2010, Advances in Analysis, Modeling, and Design*, Geotechnical Special Publication No. 199, D. Fratta, A. Puppula, and B. Muhunthan, eds., ASCE, Reston, VA, 2682-2691.

Koragappa, N., Wall, R., and Benson, C. (2008), Water Balance Cover – Case Study of a Southern California Landfill, *Proceedings, Global Waste Management Symposium 2008*, Penton Media, Orlando, 1-15.

Lee, J., Bradshaw, S., Edil, T., and Benson, C. (2010), Green Benefits of Using Coal Ashes for Subgrade Stabilization During Road Construction, *Proc. Second Intl. Conference on Sustainable Construction Materials and Technologies*, Università Politecnica delle Marche, Ancona, Italy.

Lee, J., Edil, T., Benson, C., and Tinjum, J. (2010), Use of BE^{2}ST-in-Highways for Green Highway Construction in Wisconsin, *Proc. Green Streets and Highways 2010*, ASCE, 480-494.

Li, L and Benson, C. (2005), Impact of Fouling on the Long-Term Hydraulic Behavior of Permeable Reactive Barriers, *Permeable Reactive Barriers*, Publication 298, International Assoc. of Hydrological Sciences, Oxfordshire, UK, G. Boshoff and B. Bone, eds., 23-32.

Li, L., Benson, C., Edil, T., and Hatipoglu, B. (2006), WiscLEACH: A Model for Predicting Ground Water Impacts from Fly-Ash Stabilized Layers in Roadways, *Geotechnical Engineering in the Information Technology Age*, D. DeGroot, J. DeJong, J. Frost, and L. Baise, eds., ASCE.

Li, L., Mergener, E., and Benson, C. (2003), Reactive Transport Modeling of Mineral Fouling in Permeable Reactive Barriers, *Proc. MODFLOW and More 2003: Understanding through Modeling*, International Groundwater Modeling Center, Golden, CO, 300-304.

Lin, H., Chen, J., Benson, C., and Clark, B. (2020), Sorption of Anionic Iodine and Molybdenum to Multisorbing Barrier (MSB) Materials, *Proc. Waste Management '20*, Phoenix, AZ.

Malusis, M. and Benson, C. (2006), Lysimeters versus Water-Content Sensors for Performance Monitoring of Alternative Earthen Final Covers, *Unsaturated Soils 2006*, ASCE Geotechnical Special Publication No. 147, 1, 741-752.

Manassero, M., Benson, C., and Bouazza, M. (2000), Solid Waste Containment Systems, *Proc. GeoEng2000*, Melbourne, Australia, Technomic Publishing Company, Lancaster, PA, USA, 520-642.

Metz, S. and Benson, C. (2007), Iron Foundry Slags as Permeable Reactive Barrier Materials for Removing Arsenic from Groundwater, *Geoenvironmental Engineering*, Geotechnical Special Publication 163, ASCE, Reston, VA, 1-11.

Nokkaew, K., Tinjum, J., and Benson, C. (2012), Hydraulic Properties of Recycled Asphalt Pavement and Recycled Concrete Aggregate, *State of the Art and Practice in Geotechnical Engineering, GSP No. 225*, R. Hryciw et al., Eds., ASCE, Reston VA, 1476-1485.

Norris, A., Scalia, J., Benson, C., and Shackelford, C. (2024), Review of Methods for Quantifying Polymer Loading of Enhanced-Bentonite Geosynthetic Clay Liners, *Geosynthetics: Leading the Way to a Resilient Planet, Proc. 12th International Conference on Geosynthetics*, G. Biondi, et al., eds., CRC Press/Balkema, Boca Raton, FL, 1479-1484.

O'Donnell, J., Benson, C., and Edil, T. (2010), Trace Element Leaching from Pavements with Fly Ash-Stabilized Bases and Subgrades: Experience in the Midwestern United States, *Proc. Second Intl. Conference on Sustainable Construction Materials and Technologies*, Università Politecnica delle Marche, Ancona, Italy.

O'Donnell, J., Benson, C., Edil, T., and Bradshaw, S. (2011), Leaching of Trace Elements from Pavement Materials Stabilized with Fly Ash, *Proc. Green Streets and Highways 2010*, ASCE, Reston, VA, 272-279.

Ogorzalek, A., Shackelford, C., and Benson, C. (2005). Comparison of Model Predictions and Field Data for an Alternative Cover in a Semiarid Climate, *Symp. on Mines and the Environment*, Canadian Institute of Mining, Metallurgy, and Petroleum, Montreal, Quebec, 666-680.

Othman, M., Benson, C., Chamberlain, E., and Zimmie, T. (1994), Laboratory Testing to Evaluate Changes in Hydraulic Conductivity Caused by Freeze-Thaw: State-of-the-Art, *Hydraulic Conductivity and Waste Containment Transport in Soils, STP 1142*, ASTM, S. Trautwein and D. Daniel, eds., 227-254.

Padgett, J., Breitmeyer, R., Bareither, C., Barlaz, M., and Benson, C. (2008). Biodegradability of Forest Products Under Laboratory and Bioreactor Landfill Conditions, *Proceedings, Global Waste Management Symposium 2008*, Penton Media, Orlando, 1-6.

Rauen, T. and Benson, C. (2008), Hydraulic Conductivity of a Geosynthetic Clay Liner Permeated with Leachate from a Landfill with Leachate Recirculation, *GeoAmericas 2008*, International Geosynthetics Society.

Rowe, R. et al. (2022), Protecting the Environment from Contamination with Barrier Systems: Advances and Challenges, *Proc. 20th International Conference on Soil Mechanics and Geotechnical Engineering,* Balkema, Rotterdam, 1-108.

Salihoglu, H., Chen, J., Likos, W., and Benson, C. (2016), Hydraulic Conductivity of Bentonite-Polymer Geosynthetic Clay Liners in Coal Combustion Product Leachates, *Proc. Geo-Chicago 2016: Sustainable Geoenvironmental Systems*, ASCE, GSP 271, A. De, K. Reddy, N. Yesiller, D. Zekkos, and A. Farid, eds., 438-448.

Santos, M., Chen, J., Gruber, C., van der Sloot, H., Brown, K., Kosson, D., and Benson, C. (2025), Hydrological Evaluation for Disposal of Glass Waste Forms at the Hanford Site, Washington, Washington, *Proc. Waste Management 2024*, WM Symposia Inc., 25113, 1-8. **(Superior Paper Award)**

Sawangsuriya, A., Edil, T., Benson, C. and Wang, X., A Simple Setup for Inducing Matric Suction, *Third Asian Conference on Unsaturated Soils*, 2007, Nanjing, China.

Sawangsuriya, A., Benson, C., And Wang, X. (2010), Issues for Calibration of Thermal Dissipation Sensors for Measuring Matric Suction, *Unsaturated Soils*, Buzzi, O., Fityus, S., And Sheng, D., Eds. Taylor And Francis, London, 209-214.

Scalia, J., Benson, C., Edil, T., Bohnhoff, G., and Shackelford, C. (2011), Geosynthetic Clay Liners Containing Bentonite Polymer Nanocomposite, *GeoFrontiers 2011 Advances in Geotechnical Engineering*, GSP No. 211, J. Han and D. Alazamora, eds., ASCE, Reston, VA, 2001-2009.

Scalia, J. and Benson, C. (2016), Evaluation of Na-Bentonite-Polyacrylate Mixtures to Enhance the Chemical Resistance of Geosynthetic Clay Liners, *Proc. Geo-Chicago 2016: Sustainable Geoenvironmental Systems*, ASCE, GSP 271, A. De, K. Reddy, N. Yesiller, D. Zekkos, and A. Farid, eds., 388-398.

Scalia, J. and Benson, C. (2014), Barrier Performance of Bentonite-Polyacrylate Nanocomposite to Artificial Ocean Water, *Proc. Geo-Congress 2014, Geo-Characterization and Modeling for Sustainability*, ASCE, GSP 234, M. Abu-Farsakh, X. Yu, and L. Hoyos, eds., 1826-1835.

Schlicht, P., Benson, C., Tinjum, J., and Albright, W. (2010), In-Service Hydraulic Properties of Two Landfill Final Covers in Northern California, *GeoFlorida 2010, Advances in Analysis, Modeling, and Design*, Geotechnical Special Publication No. 199, D. Fratta, A. Puppula, and B. Muhunthan, eds., ASCE, Reston, VA, 2867-2877.

Shackelford, C. and Benson, C. (2006), Selected Factors Affecting Water-Balance Predictions for Alternative Covers Using Unsaturated Flow Models, *Geotechnical Engineering in the Information Technology Age*, D. DeGroot, J. DeJong, J. Frost, and L. Baise, eds., ASCE.

Smesrud, J., Benson, C., Albright, W., Richards, J., Wright, S., Israel, T., and Goodrich, K. (2008), Lessons Learned from an Alternative Cover Pilot Test in Northern California, *Proceedings, Global Waste Management Symposium 2008*, Penton Media, Orlando, 1-20.

Somasundaram, S., Shenthan, T., Benson, C., and Nannapaneni, S. (2010), Unsaturated Hydraulic Characteristics of Soil with Significant Oversize Particles, *Proc. Fifth Intl. Conference on Unsaturated Soils*, CRC Press, Boca Raton, FL, 494-500.

Stefani, N., Likos, W., and Benson, C. (2016), Evaluation of Two Methods for Measuring Radon Flux from Earthen Radon Barriers, *Proc. Geo-Chicago 2016: Sustainable Geoenvironmental Systems*, ASCE, GSP 271, A. De, K. Reddy, N. Yesiller, D. Zekkos, and A. Farid, eds., 145-155.

Tachavises, C. and Benson, C. (1997), Flow Rates Through Earthen, Geomembrane, and Composite Cut-off Walls, *Intl. Containment Tech.*, 945-953.

Tachavises, C. and Benson, C. (1997), Hydraulic Importance of Defects in Vertical Groundwater Cutoff Walls, *In Situ Remediation of the Geoenvironment*, GSP No. 71, J. Evans, ed., ASCE, Reston, VA, 168-180.

Tan, Y., Basantis, A., Benson, C., and Chen, J. (2022), Hydraulic Properties of Sluiced Coal Combustion Products Disposed in Impoundments, *Geo-Congress 2022: Geoenvironmental Engineering; Unsaturated Soils; and Contemporary Topics in Erosion, Sustainability, and Coal Combustion Residuals*, ASCE, GSP No. 335, A. Lemnitzer and A. Stuedlein, eds., 505-513.

Tan, Y., Benson, C., Zhang, H. (2022), Interactions Between Geosynthetic Clay Liners and Concrete in Low-Level Radioactive Waste Disposal Facilities, *Proc. Waste Management '22*, WM Symposia Inc., 22337, 1-7.

Tan, Y., Chen, J., Benson, C. (2022), Predicting Hydraulic Conductivity of Geosynthetic Clay Liners Using a Neural Network Algorithm, *Geo-Congress 2022: Geoenvironmental Engineering; Unsaturated Soils; and Contemporary Topics in Erosion, Sustainability, and Coal Combustion Residuals,* ASCE, GSP No. 335, A. Lemnitzer and A. Stuedlein, eds., 21-28.

Tan, Y., and Benson, C. (2023), Effectiveness of Composite Liners in Containing PFAS, *Proc. Waste Management '23*, Phoenix, AZ, 23292, 1-7.

Tan, Y., Benson, C., Zhou, G., Bradshaw, S., and Edil, T. (2024), Hydraulic Conductivity of Two Geosynthetic Clay Liners with Different Bentonite Granule Sizes, *Proc. GeoAmericas 2024*, E3S Web of Conferences, 569, 14001, 10 p.

Tan, Y. and Benson, C. (2025), Evaluating Diffusion of Per- and Polyfluoroalkyl Substances through Composite Liners, *Geoenvironmental Engineering*, GSP No. 362, M. Othman and N. Yesiller, eds., ASCE, Reston, VA, 127-137.

Tanyu, B., Kim, W., Edil, T., and Benson, C. (2003), Comparison of Laboratory Resilient Modulus with Back-Calculated Elastic Moduli from Large-Scale Model Experiments and FWD Tests on Granular Materials, *Resilient Modulus Testing for Pavement Components,* STP 1437, G. Durham, A. Marr, and W. De Groff, eds., ASTM, West Conshohocken, PA, 191-208.

Tatlisoz, N., Benson, C., and Edil, T. (1997), Effect of Fines on the Mechanical Properties of Soil-Tire Chip Mixtures, *Testing Soil Mixed with Waste or Recycled Materials, STP 1275*, ASTM, M. Wasemiller and K. Hoddinott, eds., 93-108.

Tian, K. and Benson, C. (2014), Hydraulic Conductivity of Geosynthetic Clay Liners Exposed to Low-Level Radioactive Waste Leachate, *Proceedings Waste Management '14*, WM Symposia Inc., Phoenix, AZ, 1-15.

Tian, K. and Benson, C. (2015), Effect of Low-Level Radioactive Waste Leachate on Hydraulic Conductivity of a Geosynthetic Clay Liner, *Geosynthetics 2015*, IFAI, St. Paul, MN, 236-244.

Tian, K. and Benson, C., Yang, Y., and Tinjum, J. (2016), Effect of Radiation from Low-Level Radioactive Waste Leachate on Antioxidant Depletion in HDPE Geomembranes, Paper No. 16087, *Proceedings Waste Management '16*, WM Symposia Inc., Phoenix, AZ, 1-10.

Tian, K., Benson, C., and Likos, W. (2017), Effect of an Anion Ratio on the Hydraulic Conductivity of a Bentonite-Polymer Geosynthetic Clay Liner, *Geotechnical Frontiers 2017, Waste Containment, Barriers, Remediation, and Sustainable Geoengineering*, *GSP No. 276*, ASCE, T. Brandon and R. Valentine, eds., 180-189.

Tian, K. and Benson, C. (2018), Containing Bauxite Liquor Using Bentonite-Polymer Composite Geosynthetic Clay Liners, *Proc. 8th Intl. Conference on Environmental Geotechnics*, Springer Nature, Singapore, L. Zhan et al. (Eds.): 672–678.

Tian, K. and Benson, C. (2018), Containing Tc-99 Using a Multisorbing Barrier Material, *Proceedings Waste Management '18*, WM Symposia Inc., Phoenix, AZ, 1-6.

Tian, K., Benson, C., Yesiller, N., and Hanson, J. (2019), Evaluation of a HDPE Geomembrane from a Composite Liner After 12 Years of Atmospheric Exposure, *Geosynthetics 2019*, Industrial Fabrics Association International, St. Paul, MN, 522-527.

Tian, K., Likos, W., and Benson, C. (2016), Pore-Scale Imaging of Polymer-Modified Bentonite in Saline Solutions, *Proc. Geo-Chicago 2016: Sustainable Geoenvironmental Systems*, ASCE, GSP 271, A. De, K. Reddy, N. Yesiller, D. Zekkos, and A. Farid, eds., 468-478.

Tian, K., Tinjum, J., Benson, C., and Edil, T. (2014) Antioxidant Depletion in HDPE Geomembranes Exposed to Low-Level Radioactive Waste Leachate. *Geo-Congress 2014*, 1816-1825, doi: 10.1061/9780784413272.1781-15.

Trzebiatowski, B., Edil, T., and Benson, C. (2004), Case Study of Subgrade Stabilization Using Fly Ash: State Highway 32, Port Washington, Wisconsin, *Beneficial Reuse of Waste Materials in Geotechnical and Transportation Applications*, GSP No. 127, A. Aydilek and J. Wartman, eds., ASCE, Reston, VA, 123-136.

Vasko, S., Jo, H., Benson, C., Edil, T., and Katsumi, T. (2001), Hydraulic Conductivity of Partially Prehydrated Geosynthetic Clay Liners Permeated with Aqueous Calcium Chloride Solutions, *Geosynthetics 2001*, Industrial Fabrics Assoc. International, St. Paul, MN, 685-699.

Wang, X. and Benson, C. (2016), Constant-Head Constant-Volume Hydraulic Conductivity Testing of Porous Materials, *Proc. Geoenvironmental Engineering: Honoring David E. Daniel*, ASCE, GSP 274, C. Benson and C. Shackelford, eds., 69-79.

Waugh, W., Benson, C., and Albright, W. (2008), Monitoring the Performance of an Alternative Landfill Cover Using a Large Embedded Lysimeter, *Proceedings, Global Waste Management Symposium 2008*, Penton Media, Orlando, 1-10.

Waugh, W., Benson, C., and Albright, W. (2009), Sustainable Covers for Uranium Mill Tailings, USA: Alternative Design, Performance, and Renovation, *Proc. 12th Intl. Conference on Environmental Remediation and Radioactive Waste Management*, ICEM2009, ASME, 11-15 October 2009, Liverpool, UK.

Williams, M., Fuhrmann, M., Stefani, N., Michaud, A., Likos, W., Benson, C., and Waugh, W. (2024), Uranium Mill Tailings Radiation Control Act Cover Performance After Nearly 20 Years of Service, *Proc. Waste Management 2024*, WM Symposia Inc., 24621, 1-8. **(Superior Paper Award)**

Williams, T., Benson, C., Tian, K., Yesiller, N., and Hanson, J., (2018), Hydraulic Conductivity of a Geosynthetic Clay Liner (GCL) from a Composite Liner after 12-yr of Atmospheric Exposure, *Proc. 11th Intl. Conference on Geosynthetics*, IGS, 16-21 Sept. 2018, Seoul, Korea, 1-7.

Worthy, R., Abkowitz, M., Clarke, J., and Benson, C. (2011), Analysis of Modeling Capabilities to Predict Disposal Facility Cover Design and Performance at DOE Sites, *Proc. Waste Management '11*, WM Symposia Inc., Phoenix, AZ.

Wright, S., Arcement, B., and Benson, C. (2003), Comparison of Maximum Density of Cohesionless Soils Determined Using Vibratory and Impact Compaction Methods, *Soil and Rock America 2003*, Verlag Gluck auf GMBH, Essen, Germany, 1709-1716.

Yilmaz, M., Olson, R., Tan, Y., Benson, C., Edil, T., and Bradshaw, S. (2023), Characteristics of Black Goo From Leachate Collection Systems at Two North American Landfills, Proc. 9th International Congress on Environmental Geotechnics, Vol. 3., Volume 3, T. Baser et al., ed., International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), 26-30.

Zhu, J., Tan, Y., Benson, C., Youngblood, J., Bradshaw, S., and Edil, T. (2024), Using Viscosity as an Index for Polymer Loading of Bentonite-Polymer Composite Geosynthetic Clay Liners, *Proc. GeoAmericas 2024*, E3S Web of Conferences, 569, 14002, 9 p.

Books

Albright, W., Benson, C., and Waugh, W. (2010), *Water Balance Covers for Waste Containment: Principles and Practice*, ASCE Press, Reston, VA, 158 p.

Chapters in Books & Other Periodicals

Benson, C. (2005), Materials Stability and Applications, in *Barrier Systems for Environmental Contaminant Containment and Treatment,* C. Chen, H. Inyang, and L. Everett, eds., CRC Press, Boca Raton, FL, 143-208.

Benson, C. and Scalia, J. (2010), Chapter 10: Hydrologic Performance of Final Covers Containing GCLs, in *Geosynthetic Clay Liners for Waste Containment Facilities*, A. Bouazza and J. Bowders, eds., CRC Press, Boca Raton, FL, 203-211.

Doyle, M., Lee, S., Benson, C., and Pariza, M. (2010), Decontamination and Disposal of Contaminated Foods, *Wiley Handbook of Science and Technology for Homeland Security*, J. Voeller, ed., John Wiley and Sons, NY, 1-15.

Li, L. and Benson, C. (2005), Reactive Transport in the Saturated Zone: Case Histories for Permeable Reactive Barriers, *Water Encyclopedia*, *Volume I – Ground Water*, J. Lehr and J. Keeley, eds., John Wiley, 518-524.

Non-Refereed Conference Papers

Abichou, T., Albright, W., and Benson, C., (2003). Field Tests of Conventional and Alternative Final Cover Systems for Landfill Final Covers. *SWANA WASTECON 2003 Proc.*, 143-158.

Abichou, T., Edil, T., Benson, C., Berilgen, M. (2002), Mass Behavior of Soil-Tire Chip Backfills, *Beneficial Use of Recycled Materials in Transportation Applications*, Air and Waste Management Association, Sewickley, PA, 689-698.

Abu-Hassanein, Z. and Benson, C. (1994), Using Electrical Resistivity for Compaction Control of Compacted Soil Liners, *Proc. Tailings and Mine Waste '94*, Jan. 19-21, Ft. Collins, CO, 177-189.

Albright, W., Benson, C., Gee, G., Rock, S., and Abichou, T. (2001), Tests of Alternative Final Landfill Covers in Arid and Semi-Arid Areas Using Innovative Water Balance Monitoring Systems, *Proc. 36th Annual Engineering Geology & Geotechnical Engineering Symp.*, 33-41.

Albright, W., Benson, C., Gee, G., and Rock, S. (2000), Tests of Alternative Final Landfill Covers Using Innovative Water Balance Monitoring Systems, *Proc. Geological Society of America Annual Meeting*, Reno, Nevada, 32(7), 126.

Benson, C., Edil, T., Bin-Shafique, S. (2007), Leaching of Trace Elements from Soils Stabilized with Coal Fly Ash, *Proc. Flue Gas Desulphurization Byproducts at Coal Mines*, K. Vories and A. Harrington, Eds., US Dept. of Interior Office of Surface Mining Coal Research Center, Carbondale, IL, 101-111.

Benson, C. (2005), General Report on Technical Session 3a: Waste Disposal and Management, *Proc. 16th Intl. Conference on Soil Mechanics and Geotechnical Engineering*, Japanese Geotechnical Society, Tokyo, 179-185.

Benson, C., Bohnhoff, G., Apiwantragoon, P., Ogorzalek, A., Shackelford, C., and Albright, W. (2004), Comparison of Model Predictions and Field Data for an ET Cover, *Tailings and Mine Waste '04*, Balkema, Leiden, Netherlands, 137-142.

Benson, C. (2000), Liners and Covers for Waste Containment, *Proc. Fourth Kansai Intl. Geotechnical Forum, Creation of a New Geo-Environment,* Japanese Geotechnical Society, Kyoto, Japan, 1-40.

Benson, C. (1999), Final Covers for Waste Containment Systems: A North American Perspective, *Proc. XVII Conference of Geotechnics of Torino, Control and Management of Subsoil Pollutants*, Italian Geotechnical Society, Torino, Italy, 1-32.

Benson, C. (1999), Environmental Geotechnics in the New Millennium, *Geotechnics for Developing Africa*, G. Wardle, G. Blight, and A. Fourie, Eds., Balkema, Rotterdam, 9-22.

Benson, C. and Khire, M. (1997), Earthen Materials in Surface Barriers, *Barrier Technologies for Environmental Management*, National Academy Press, National Research Council, D79-D89.

Benson, C., Olson, M., and Bergstrom, W. (1995), Field Evaluation of Five Landfill Liner Insulations, *Proc. Eighteenth Intl. Madison Waste Conference*, Sept. 23-24, Madison, WI, 309-318.

Benson, C. (1994), Research Developments in Clay Liner Construction, *Proc. 32nd Annual Intl. Solid Waste Exposition*, Solid Waste Association of North America, Silver Spring, MD, 81-93.

Benson, C., Chamberlain, E., and A. Erickson (1994), Methods for Assessing Freeze-Thaw Damage in Compacted Soil Liners, *Proc. Seventeenth Intl. Madison Waste Conference*, Madison, WI, Sept. 21-22, 185-197.

Brown, B., Bradshaw, S., Edil, T., and Benson, C. (2015), Leaching from Roadways Stabilized with Fly Ash: Data Assessment and Synthesis, *Proc., World of Coal Ash (WOCA) Conference*, Center for Applied Energy Research, University of Kentucky, Louisville, 1-10.

Bohnhoff, G., Shackelford, C., Malusis, M., Scalia, J., Benson, C., Edil, T., Di Emiddio, G., Katsumi. T., and Mazzieri, F. (2013), Novel Bentonites for Containment Barrier Applications, *Proc., 18th Intl. Conference on Soil Mechanics and Geotechnical Engineering-Challenges and Innovations in Geotechnics*, P. Delage et al., eds., Presses des Ponts, Paris, 2997-3000.

Christman, M., Edil, T., and Benson, C. (1999), Characterization of Well Seals Using an Ultrasonic Method, *Proc. Symp. On Application of Geophysics to Engineering and Environmental Problems*, Environmental and Engineering Geophysics Society, Wheat Ridge, CO, 879-888.

Benson, C. and Boutwell, G. (1992), Compaction Control and Scale-Dependent Hydraulic Conductivity of Clay Liners, *Proc. of the 15th Intl. Madison Waste Conference*, Madison, WI, Sept. 23-24, 62-83.

Benson, C., Hardianto, F., Motan, E., and Mussatti, D. (1992), Comparison of Laboratory and In Situ Hydraulic Conductivity Tests on a Full-Scale Test Pad, *Mediterranean Conference on Environmental Geotech.*, Cesme, Turkey, May 25-27, 219-228.

Benson, C. and Othman, M. (1991), Geotechnical Characteristics of Compacted Municipal Solid Waste Compost, *Proc. of the 34th Annual Meeting of the Association of Engineering Geologists*, Sept. 30-Oct. 4, Chicago, IL, 683-691.

Benson, C. (1991), Predicting Excursions beyond Regulatory Thresholds of Hydraulic Conductivity Using Quality Control Measurements, *Proc. of the First Canadian Conference on Environmental Geotechnics*, Montreal, May 14-17, 447-454.

Benson, C. (1990), A Minimum Thickness of Compacted Soil Liners, *of the 13th Annual Madison Waste Conference*, Madison, WI, September 19-20, 395-422.

Benson, C. (1989), Index Tests for Evaluating the Effect of Leachate on a Soil Liner, *Proc. Second Intl. Symposium on Environmental Geotechnology*, Shanghai, China, 222-228.

Benson, C., Charbeneau, R., and Daniel, D. (1988), Reliability of Compacted Soil Liners, *Proc. of the National Conference on Hydraulic Engineering*, ASCE, Colorado Springs, Colorado, 564-569.

Elder, C., Benson, C., Eykholt, G. (2001), Economic and Performance Based Design of Monitoring Systems for PRBs, *Proc. 2001 Intl. Containment and Remediation Conference*, Institute for International Cooperative Environmental Research, Florida State University, Tallahassee, FL, USA, 1-5.

Erickson, A., Chamberlain, E., and Benson, C. (1994), Effects of Frost Action on Covers and Liners in Cold Environments, *Proc. Seventeenth Intl. Madison Waste Conference*, Madison, WI, Sept. 21-22, 198-220.

Foose, G., Tachavises, C., Benson, C., and Edil, T. (1998), Analyzing Geoenvironmental Engineering Problems with MODFLOW, *Proc. MODFLOW '98*, Colorado School of Mines, Golden, CO, 1, 81-88.

Gibson, S., Benson, C., and Edil, T. (1999), Assessing Exploratory Borehole Seals with Electrical Geophysical Techniques, *Proc. Symp. On Application of Geophysics to Engineering and Environmental Problems*, Environmental and Engineering Geophysics Society, Wheat Ridge, CO, 869-878.

Gulec, S., Benson, C., and Edil, T. (2003), Effects of Acid Mine Drainage (AMD) on the Engineering Properties of Geosynthetics, *Tailings and Mine Waste '03*, Swets & Zeitlinger, Lisse, 173-179.

Hardianto, F. and Benson, C. (1993), Effect of Specimen Size on Hydraulic Conductivity Measurement of Compacted Soil Liners, *Proceedings ASCE Annual Florida Section Meeting*, Sept. 9-11, Orlando, 1-12.

Hill, T. and Benson, C. (1999), Hydraulic Conductivity of Compacted Mine Rock Backfill, *Tailings and Mine Waste '99*, Balkema, Rotterdam, 373-379.

Jo, H., Benson, C., and Edil, T. (2004). Long-Term Hydraulic Conductivity and Cation Exchange of a Geosynthetic Clay Liner (GCL) Permeated with Inorganic Salt Solutions, *Proc. 2004 Annual Conference, Korean Society of Soil and Groundwater Environment*, Jeonju, Korea, 59-62.

Katsumi, T., Ogawa, A., Numata, S., Benson, C., Kolstad, D., Jo, H., Edil, T., and Fukagawa, R. (2002), Geosynthetic Clay Liners Against Inorganic Chemical Solutions, *Proc. Second Japan-Korea Joint Seminar on Geoenvironmental Engineering*, Kyoto University, Japan, 27-32.

Katsumi, T., Benson, C., Foose, G., and Kamon, M. (1999), Calculating Chemical Leakage from Landfill Bottom Liners, *Proc. 34th Annual Conference*, Japanese Geotechnical Society, Tokyo.

Katsumi, T., Benson, C., Jo, H., and Edil, T. (1999), Hydraulic Conductivity of GCLs Permeated with Chemical Solutions, *Proc. 54th Annual Conference*, Japanese Society of Civil Engineers, Tokyo.

Katsumi, T., Benson, C., Foose, G., and Kamon, M. (1999), Performance-Based Method for Analyzing Landfill Liners, *Geoenvironmental Engineering*, R. Yong and H. Thomas, Eds., British Geotechnical Society, Thomas Telford Publishers, London, 21-28.

Khire, M., Benson, C., Bosscher, P., and Pliska, R. (1994), Field-Scale Comparison of Capillary and Resistive Landfill Covers in an Arid Climate, *Proc. 14th Annual Hydrology Days*, Fort Collins, CO, 195-209.

Kim, H. and Benson, C. (1999), Oxygen Transport Through Multilayer Composite Caps Over Mine Waste, *Proc. Sudbury '99 - Mining and the Environment II*, Centre in Mining and Mining Environment Research, Laurentian University, Sudbury, Ontario.

Kumthekar, U., Chiou, J., Prochaska, M., and Benson, C. (2002), Development of Long-Term Monitoring System to Evaluate Cover System Performance, *Proc. Waste Management '02*, WM Symposia Inc., Tucson, AZ.

Kumthekar, U., Chiou, J., Prochaska, M., and Benson, C. (2002), Development of Long-Term Monitoring System to Monitor Cover System Conditions, *Spectrum 2002, 9th Biennial Intl. Conference On Nuclear & Hazardous Waste Management*, Reno, Nevada.

Lane, D., Benson, C., Bosscher, P., and Pliska, R. (1992), Construction and Hydrologic Observations of Three Instrumented Final Covers, *Proc. 15th Intl. Madison Waste Conference*, Madison, Sept. 23-24, 231-250.

Miller, E., Bahia, H., Benson, C., Khatri A., and Braham, A. (2001), Utilization of Waste Foundry Sand in Hot Mix Asphalt Mixtures, *American Foundry Society Transactions*, 103(1), 1393-1407.

Motan, E., Benson, C., and Edil, T. (1997), Shear Strength of Municipal Solid Waste, *Proc. WasteTech '97*, National Solid Waste Management Assoc., Washington, DC.

Ogorzalek, A., Shackelford, C., and Benson, C. (2005). Comparison of Model Predictions and Field Data for an Alternative Cover in a Semiarid Climate. *Symposium on Mines and the Environment*, Rouyn-Noranda, Quebec, Canada, May 15-18, 2005.

Othman, M. and Benson, C. (1991), Influence of Freeze-Thaw on the Hydraulic Conductivity of a Compacted Clay, *Proc. of the 14th Annual Madison Waste Conference*, Madison, WI, Sept. 25-26, 296-312.

Rashad, S. and Benson, C. (1994), Improving Subsurface Characterization and Prediction of Contaminant Transport, *Proc., ASCE Annual Hydraulic Engineering Conference*, 277-281.

Senol, A., Bin-Shafique, M., Edil, T., and Benson, C. (2002), Use of Class C Fly Ash for Stabilization of Soft Subgrade, *Proc. 5th Intl. Congress on Advances in Civil Engineering*, Istanbul Technical University, Istanbul, Turkey, 963-972.

Simon, D., Alumbaugh, D., and Benson, C. (2001), Quantitative Characterization of an IAS Air Plume Using Geophysics, *Proc. 2001 Intl. Containment and Remediation Conference*, Institute for International Cooperative Environmental Research, Florida State University, Tallahassee, FL, USA, 1-4.

Waugh, W., Glenn, E., Benson, C., Albright, W., Brusseau, M., Bush, R., and Dayvault, J. (2016), Applications of Ecological Engineering Remedies for Uranium Processing Sites, USA, *Proc. Intl. Conference on Advancing the Global Implementation of Decommissioning and Environmental Remediation Programs*, 23-27 May 2016, Madrid, Spain.

Waugh, W., Albright, W., and Benson, C. (2007), Alternative Covers: Enhanced Soil Water Storage and Evapotranspiration in the Source Zone, Enhancements to Natural Attenuation: Selected Case Studies, T. Early, Ed., Savannah River National Laboratory, Aiken, SC, 9-15.

Yesiller, N., Benson, C., Edil, T., and Klima, J. (1997), Assessment of Cased-Borehole Seals Using and Ultrasonic Method, *Proc. Fifth Great Lakes Geotechnical/Geoenvironmental Conference*, Ann Arbor, Michigan, 133-152.

Reviews, Editorials, and Magazine Articles

Albright, W., Benson, C., G. Gee, Abichou, T., Roesler, A., and Rock, S. (2003), Examining the Alternatives, *Civil Engineering*, 73(1), 70-75.

Barlaz, M., Benson, C., Castaldi, M., and Luettich, S. (2016), Diagnosing and Understanding Elevated Temperature Landfills, Part 1 - Characteristics and Management Challenges, *Waste360*, Penton Media, New York.

Barlaz, M., Benson, C., Castaldi, M., and Luettich, S. (2017), Diagnosing and Understanding Elevated Temperature Landfills, Part 2 – Biological Reactions, *Waste360*, Penton Media, New York.

Barlaz, M., Benson, C., Castaldi, M., and Luettich, S. (2017), Diagnosing and Understanding Elevated Temperature Landfills, Part 3 – Chemical Reactions, *Waste360*, Penton Media, New York.

Benson, C. (2016), The Future of Environmental Geotechnics: Creating the New Value Proposition, *Environmental Geotechnics*, 3(2), 61-62.

Benson, C. (2014), Sustainable Water Balance Final Cover for Missoula Landfill, *Montana Solid Waste News*, Summer 2014, Montana Department of Environmental Quality, Helena, MT, 5.

Benson, C. (2012), The Year Ahead, *Geo-Strata*, November/December, 8.

Benson, C. (2006), Numerical Modeling in Geoenvironmental Practice, *Geo-Strata*, Aug. 2006.

Benson, C. (1996), An Overview of Uncertainty '96, *Geotechnical News*, June, 1996.

Benson, C. and Breitmeyer, R. (2010), Using Inversion to Improve Prediction in Geoenvironmental Engineering, *Geo-Strata*, 14(1), 22-27.

Benson, C. and Pliska, R. (1996), HELP Needs Help from the Field, *Waste Age*, March 1996.

Benson, C. and Edil, T. (1995), Using Shredded Scrap Tires in Civil & Environmental Construction, *Resource Recycling*, Oct. 1995.

Benson, C. (1992), Remotely Monitoring Field-Scale Performance of Final Covers, *Technology Report*, Waste Management, Inc., First Quarter 1992.

Benson, C. (1990), Waste Geotechnics at the University of Wisconsin-Madison, *Geotechnical News*, December, 1990, 43-46.

Benson, C. (1990), Review of *Clay Liners for Waste Management Facilities*, *J. of Environmental Quality*, November 1990.

Bradshaw, S., Benson, C., Edil, T., and Gallagher, B. (2023), Life Cycle Impacts of Harvested Ash in Concrete, *Ash at Work, Applications, Science, and Sustainability of Coal Ash*, Issue 2, 16-19.

Edil, T. and Benson, C. (2002), Use of Industrial By-Products as Geo-Materials, *Geo-Strata*, April 2002.

Edil, T. and Benson, C. (2006), Geotechnical Applications of CCPs in Wisconsin, *Ash At Work*, American Coal Ash Association, Summer 2004, 16-20.

Fox, P. and Benson, C. (2014), Forum Articles and the JGGE, *J. Geotech. Geoenvironmental Eng.*, 01614002-1.

McCartney, J. and Benson, C. (2011), Laboratory Testing for Unsaturated Soils: A Primer, *Geo-Strata*, 15(2), 19-23.

Reports

Abichou, T., Benson, C., and Edil, T. (1999), Beneficial Reuse of Foundry Byproducts, Environmental Geotechnics Report 99-1, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Abichou, T., Benson, C., and Edil, T. (1998), Beneficial Reuse of Foundry Sands in Construction of Hydraulic Barrier Layers, Environmental Geotechnics Report 98-2 Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Abichou, T., Benson, C., and Edil, T. (1998), Field Hydraulic Conductivity of Three Test Pads Constructed with Foundry Sands, Environmental Geotechnics Report 98-14, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Acosta, H., Edil, T., and Benson, C. (2003), Soil Stabilization and Drying Using Fly Ash, Geo Engineering Report 03-03, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Albright, W. and Benson, C. (2002), Alternative Cover Assessment Program 2002 Annual Report, Publication No. 41182, Desert Research Institute, Reno, Nevada.

Bareither, C., Karimi, S., Scalia, J., and Benson, C. (2023), Evaluation and Management of Wet Waste Disposal in Municipal Solid Waste Landfills, Environmental Research and Education Foundation, Raleigh, NC.

Bareither, C., Barlaz, M., Doran, M., and Benson, C. (2014), Retrospective Analysis of Wisconsin's Landfill Organic Stability Rule: Is the Rule Meeting Its Objectives?, Sustainability Report No. 14-07, Office of Sustainability, University of Wisconsin-Madison, Madison, Wisconsin.

Bareither, C., Benson, C., Barlaz, M., and Morris, J. (2008), Performance of North American Bioreactor Landfills, Office of Research and Development, US Environmental Protection Agency, Cincinnati, Ohio.

Bareither, C., Edil, T., and Benson, C. (2007), Determination of Shear Strength Values for Granular Backfill Materials Used by WisDOT, SPR No. 0092-05-08, Wisconsin Highway Research Program, Madison, WI.

Bazzell, D., Benson, C., Cancian, M., Drinkwater, N., Goldman, I., Gunther, A., Lewis, J., May, K., Meinholz, L., Radomski, N., Seshadri, A., Underwood, J., Warfield, T., Gustafson, A., Norris, T., and Hildebrand, S. (2014), University of Wisconsin-Madison Budget Allocation Model Past, Present and Possibilities, Report to the Chancellor, Budget Model Review Committee, University of Wisconsin-Madison.

Benson, C. (2021), Water Flow in Coal Combustion Products and Drainage of Free Water, Technical Brief 3002021963, Electric Power Research Institute, Palo Alto, CA.

Benson, C. (2019), White Paper: Strategies for Containment at Coal Combustion Product Facilities, Report to Electric Power Research Institute, Palo Alto, CA.

Benson, C. and Benavides, J. (2018), Geochemical Assessment of Long-Term Leachate Quality and Impacts of Wastewater Management Practices at Coal Combustion Product (CCP) Storage Facilities – Progress Summary, Report No. GENV-18-09, School of Engineering, University of Virginia.

Benson, C. and Gustitus, S. (2018), Predicting Long-Term Percolation from the SDF Closure Cap, Report No. GENV-18-05, School of Engineering, University of Virginia.

Benson, C. and Tan, Y. (2023), Data Summary Report: Hydraulic Conductivity of Bentonite-Polymer Composite (BPC) Geosynthetic Clay Liners Permeated with an Acidic Copper Heap Leach Solution, Report No. WGL-23-16, Wisconsin Geotechnics Laboratory, University of Wisconsin-Madison.

Benson, C., Tan, Y., Benavides, J. (2022), Hydrologic Analysis of Disposal Basins for Coal Combustion Products, Report No. 3002023682, Electric Power Research Institute (EPRI), Palo Alto, CA,

Benson, C. and Tian, K. (2018), Stress-Induced Porewater Pressures in the Vadose Zone Beneath the Environmental Management Waste Management Facility, Report No. GENV-18-09, School of Engineering, University of Virginia.

Benson, C., Brown, B., Edil, T., and Bradshaw, S., (2015), Leaching from Roadway Substructures Constructed with Coal Combustion Products, Report No. 3002006091, Electric Power Research Institute (EPRI), Palo Alto, CA.

Benson, C., Chen, J., and Edil, T. (2014), Engineering Properties of Geosynthetic Clay Liners Permeated with Coal Combustion Product Leachates, Report No. 3002003770, Electric Power Research Institute (EPRI), Palo Alto, CA.

Benson, C., Chen, J., Edil, T., and Likos, W. (2016), Hydraulic Conductivity of Compacted Soil Liners Permeated with Coal Combustion Product Leachates, Report No. 3002008482, Electric Power Research Institute (EPRI), Palo Alto, CA.

Benson, C., Albright, W., Fratta, D., Tinjum, J., Kucukkirca, E., Lee, S., Scalia, J., Schlicht, P., and Wang, X. (2011), Engineered Covers for Waste Containment: Changes in Engineering Properties & Implications for Long-Term Performance Assessment, NUREG/CR-7028, Office of Research, U.S. Nuclear Regulatory Commission, Washington. Appendix

Benson, C., Edil, T., Lee, J., and Bradshaw, S. (2010), Quantifying the Benefits of Using Coal Combustion Products in Sustainable Construction, Report No. 1020552, Electric Power Research Institute (EPRI), Palo Alto, CA.

Benson, C. and Oren, A. (2009), Factors Contributing to Excessive Leakage from a Waste Water Lagoon in Heber Valley, Utah, Geo Engineering Report No. 09-32, University of Wisconsin, Madison, Wisconsin.

Benson, C., Lee, S., and Oren, A. (2008), Evaluation of Three Organoclays for an Adsorptive Barrier to Manage DNAPL and Dissolved-Phase Polycyclic Aromatic Hydrocarbons (PAHs) in Ground Water, Geo Engineering Report No. 08-24, University of Wisconsin, Madison, Wisconsin.

Benson, C. (2008), On-Site Disposal Facilities for Department of Energy Sites: Current Status and Future Implications, Independent Technical Review Committee, US Department of Energy, Washington, DC.

Benson, C., Abichou, T., Wang, X., Gee, G., and Albright, W. (1999), Test Section Installation Instructions – Alternative Cover Assessment Program, Environmental Geotechnics Report 99-3, Dept. of Civil & Environmental Engineering, University of Wisconsin-Madison.

Benson, C., Albright, W., Ray, D., and Smegal, J. (2008), Review of the Environmental Management Waste Management Facility at Oak Ridge, Independent Technical Review Committee, US Department of Energy, Washington, DC.

Benson, C., Albright, W., Ray, D., and Smegal, J. (2008), Review of Issues Associated with the Proposed On-Site Waste Disposal Facility (OSWDF) at Portsmouth, Independent Technical Review Committee, US Department of Energy, Washington, DC.

Benson, C., Albright, W., Ray, D., and Smegal, J. (2008), Review of Proposed On-Site Disposal Facility at the Paducah Gaseous Diffusion Plant, Independent Technical Review Committee, US Department of Energy, Washington, DC.

Benson, C., Albright, W., Ray, D., and Smegal, J. (2008), Review of Disposal Practices at the Nevada Test Site, Independent Technical Review Committee, US Department of Energy, Washington, DC.

Benson, C., Albright, W., Ray, D., and Smegal, J. (2008), Review of Disposal Practices at the Savannah River Site, Independent Technical Review Committee, US Department of Energy, Washington, DC.

Benson, C., Albright, W., and Ray, D. (2007), Evaluating Operational Issues at the Environmental Restoration Disposal Facility at Hanford, Independent Technical Review Committee, US Department of Energy, Washington, DC.

Benson, C., Albright, W., Ray, D., and Smegal, J. (2007), Review of the Idaho CERCLA Disposal Facility (ICDF) at Idaho National Laboratory, Independent Technical Review Committee, US Department of Energy, Washington, DC.

Benson, C., Albright, W., Wang, X., and MacDonald, E. (2006), Assessment of the ACAP Test Sections at Kiefer Landfill: Hydraulic Properties and Geomorphology, Geo Engineering Report No. 02-16, University of Wisconsin, Madison, Wisconsin.

Benson, C., Barlaz, M., Lane, D., and Rawe, J. (2003), State-of-the-Practice Review of Bioreactor Landfills, Geo Engineering Report 03-05, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C., Kucukkirca, I., and Scalia, J. (2008), Properties of Geosynthetics Exhumed from the Seven Mile Creek Landfill Eau Claire, Wisconsin, Geo Engineering Report No. 08-22, University of Wisconsin, Madison, Wisconsin.

Benson, C., Lee, S., Wang, X., Albright, W., and Waugh, W. (2008), Hydraulic Properties and Geomorphology of the Earthen Component of the Final Cover at the Monticello Uranium Mill Tailings Repository, Geological Engineering Report No. 08-04, University of Wisconsin, Madison, Wisconsin.

Benson, C. and Wang, X. (1998), Soil Water Characteristic Curves for Solid Waste, Environmental Geotechnics Report 98-13, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C., Waugh, W., Albright, W., and Smith, G. (2013), Cover Performance Enhancement Tests at the Grand Junction, Colorado Disposal Site: Construction Documentation, Material Testing, and Instrument Calibration, Report LMS/GRJ/S07112, Office of Legacy Management, US Department of Energy.

Benson, C., Albrecht, B., Motan, E., and Querio, A. (1998), Equivalency Assessment for an Alternative Final Cover Proposed for the Greater Wenatchee Regional Landfill and Recycling Center, Environmental Geotechnics Report 98-6, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. (1998), Comparison of the Effectiveness of Prescriptive and Alternative Covers: Mead Paper, Escanaba, Michigan, Environmental Geotechnics Report 98-13 Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. (1997), A Review of Alternative Landfill Cover Demonstrations, Environmental Geotechnics Report 97-1, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. and Hill, T. (1997), Results of Field Hydraulic Conductivity Tests Conducted on Mine Backfill: Flambeau Mine, Environmental Geotechnics Report 97-4, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. and Wang, X. (1997), Assessment of Green Sands from Wagner Castings Co. as Barrier Materials for Landfill Covers, Environmental Geotechnics Report 97-8, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C., Bosscher, P., and Jong, D. (1997), Predicting Seasonal Changes in Pavement Stiffness and Capacity Caused by Freezing and Thawing, Geotechnical Engineering Report 97-9, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. and Wang, X. (1996), Field Hydraulic Conductivity Assessment of the NCASI Final Cover Test Plots, Environmental Geotechnics Report 96-9, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. (1996), Final Cover Hydrologic Evaluation - Project Summary, Environmental Geotechnics Report 96-4, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. (1994), Assessment of Air Permeability and Freeze-Thaw Resistance of Soils Proposed for Use in the Final Cover at Greater Wenatchee Regional Landfill, Environmental Geotechnics

Report 94-3, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. and Rashad, S. (1994), Using Co-Kriging to Enhance Hydrogeologic Characterization, Final Report-Year 2, Environmental Geotechnics Report 94-1, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C., Khire, M., and Bosscher, P. (1993), Final Cover Hydrologic Evaluation: Phase II - Final Report, Environmental Geotechnics Report 93-4, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. and Bosscher, P. (1992), Effect of Winter Exposure on the Hydraulic Conductivity of a Test Pad, Environmental Geotechnics Report 92-8, Department of Civil and Environmental Engineering, University of Wisconsin- Madison.

Benson, C. (1992), Comparison of In Situ and Laboratory Measurements of Hydraulic Conductivity on a Test Pad with Construction Defects, Environmental Geotechnics Report 92-7, Department of Civil and Environmental Engineering, University of Wisconsin- Madison.

Benson, C., Zhai, H., and Rashad, S. (1992), Assessment of Construction Quality Control Measurements and Sampling Frequencies for Compacted Soil Liners, Environmental Geotechnics Report 92-6, Department of Civil and Environmental Engineering, University of Wisconsin- Madison.

Benson, C. and Khire, M. (1992), Soil Reinforcement with Strips of Reclaimed HDPE, Environmental Geotechnics Report 92-5, Department of Civil and Environmental Engineering, University of Wisconsin- Madison.

Benson, C. and Hardianto, F. (1992), Hydraulic Conductivity Assessment of Compacted Soil Liners: Phase I-Final Report, Environmental Geotechnics Report 92-4, Department of Civil and Environmental Engineering, University of Wisconsin- Madison.

Benson, C. and Cooper, S. (1992), Reducing Uncertainty in Hydraulic Conductivity Using Soil Classifications from the Cone Penetrometer - Progress Report for First Quarter of Work, Environmental Geotechnics Report 92-2, Department of Civil and Environmental Engineering, University of Wisconsin- Madison.

Benson, C. and Lane, D. (1992), Final Cover Hydrologic Evaluation - Review of First Quarter of Work, Environmental Geotechnics Report No. 92-1, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. (1991), Quality Assurance and Hydraulic Conductivity Assessment - Review of First Six Months Work, Environmental Geotechnics Report No. 91-6, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. (1991), Hydrologic Analysis of a Co-Composter Landfill Cell, Environmental Geotechnics Report No. 91-4, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. and Othman, M. (1991), Effect of Freeze-Thaw on the Hydraulic Conductivity of Compacted Clay, Environmental Geotechnics Report No. 91-3, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. (1991), Minimum Thickness of Compacted Soil Liners, Environmental Geotechnics Report No. 91-2, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Benson, C. (1989), A Stochastic Analysis of Water and Chemical Flow in Compacted Soil Liners, Ph.D. Dissertation, University of Texas at Austin, Austin, Texas, 246 p.

Benson, C. (1987), A Comparison of In Situ and Laboratory Measurements of Hydraulic Conductivity, Geotechnical Engineering Report 87-2 and M.S. Thesis, University of Texas at Austin, 80 p.

Bin-Shafique, S., Edil, T., Benson, C., and Senol, A. (2003), Incorporating a Fly Ash Stabilized Layer into Pavement Design – Case Study, Geo Engineering Report 03-04, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Bin-Shafique, S., Benson, C., and Edil, T. (2002), Leaching of Heavy Metals from Fly Ash Stabilized Soils Used in Highway Pavements, Geo Engineering Report 02-14, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Bolen, M., Roesler, A., Benson, C., and Albright, W. (2001), Alternative Cover Assessment Program: Phase II Report, Geo-Engineering Report No. 01-10, University of Wisconsin, Madison, WI.

Bosscher, P., Jong, D., and Benson, C. (1998), User's Guide for UW Frost, Geotechnical Engineering Report 98-11 Dept. of Civil and Environmental Engineering, Univ. of Wisconsin-Madison.

Bradshaw, S. and Benson, C. (2011), Effect of Cation Exchange During Subgrade Hydration and Municipal Solid Waste Leachate Permeation on the Hydraulic Conductivity of Geosynthetic Clay Liners, Geotechnics Report 11-9, University of Wisconsin, Madison, WI.

Bradshaw, S., Benson, C., and Edil, T. (2023), Harvested Coal Ash Used as a Cement Replacement in Concrete: Life Cycle Impacts, Report No. 3002024165, Electric Power Research Institute, Palo Alto, CA.

Camargo, F., Edil, T., Benson, C., and Martono, W. (2008), In Situ Stabilization of Gravel Roads with Fly Ash, Geo-Engineering Report No. 08-25, University of Wisconsin, Madison, WI.

Chamberlain, E., Erickson, A., and Benson, C. (1997), Frost Resistance of Cover and Liner Materials for Landfills and Hazardous Waste Sites, Report 97-29, US Army Cold Regions Research and Engineering Laboratory, Hanover, NH.

Chen, J. and Benson, C. (2023), Leachate Generation Rates for Coal Combustion Product Landfills - Effects of Climate, Size, Placement, and Final Cover, Report No. 3002027198, Electric Power Research Institute, Palo Alto, CA.

Christman, M., Edil, T., Benson, C., and Riewe, T. (1999), Field Evaluation of Annular Well Seals, Environmental Geotechnics Report 99-2, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Cooper, S. and Benson, C. (1993), An Evaluation of How Subsurface Characterization Using Soil Classifications Affects Predictions of Contaminant Transport, Environmental Geotechnics Report 93-1, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Dingrando, J., Benson, C., and Edil, T. (1999), Beneficial Reuse of Foundry Sand in Controlled Low-Strength Material, Environmental Geotechnics Report 99-5 Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Edincliler, A., Benson, C., and Edil, T. (1996), Shear Strength of Municipal Solid Waste, Environmental Geotechnics Report 96-2, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Edil, T. and Benson, C. (2002), Compatibility of Containment Systems with Mine Waste Liquids, Report No. WRI GRR 01-09, Water Resources Institute, University of Wisconsin-Madison.

Elder, C., Benson, C., and Eykholt, G. (1998), Air Plume Conceptualization and Mass Transfer Modeling for In Situ Air Sparging, Environmental Geotechnics Report 98-3, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Foose, G., Benson, C., Edil, T. (1996), Methods for Evaluating the Effectiveness of Landfill Liners, Environmental Geotechnics Report 96-10, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Foose, G., Benson, C., and Edil, T. (1995), Evaluating the Effectiveness of Landfill Liners, Environmental Geotechnics Report 95-4, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Foose, G., Benson, C., and Bosscher, P. (1993), Shear Strength of Sand Reinforced with Shredded Waste Tires, Environmental Geotechnics Report 93-2, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Fuhrmann, M., Benson, C. Waugh, J., Williams, M., and Arlt, H. (2019), Proceedings of the Radon Barriers Workshop, NUREG/CP-0312, Office of Nuclear Regulatory Research, US Nuclear Regulatory Commission, Washington.

Gibson, S., Edil, T., and Benson, C. (1999), Assessing Exploratory Borehole Seals with Electrical Geophysical Techniques, Environmental Geotechnics Report 99-4 Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Goodhue, M., Edil, T., and Benson, C. (1998), Reuse of Foundry Sands in Reinforced Earth Structures, Environmental Geotechnics Report 98-16, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Grasso, D., Benson, C., Carrico, A., Chandran, K., Clough, G., Crittenden, J., Greenbaum, D., Hamburg, S., Harmon, T., Hughes, J., Jones, K., Marr, L., Perciasepe, R., Polasky, S., Savitz, M., Scott, N., Trussell, R., and Zimmerman, J. (2018), Environmental Engineering for the 21st Century Addressing the Grand Challenges, Consensus Study Report, National Academies Press, Washington, DC.

Gurdal, T., Benson, C., and Albright, W. (2003), Hydrologic Properties of Final Cover Soils from the Alternative Cover Assessment Program, Geo Engineering Report 03-02, Geo Engineering Program, University of Wisconsin-Madison.

Hensel, B., Benson, C., Bittner, A., and Kondziolka, J. (2019), Relative Liner Performance for Coal Combustion Product Management Sites - Conceptual Review and Model Evaluation for Surface Impoundments, Report No. 3002016498, Electric Power Research Institute, Palo Alto, CA.

IAEA (2023), Technical Aspects Related to the Design and Construction of Engineered Containment Barriers for Environmental Remediation, Technical Reports Series No. 493, International Atomic Energy Agency, Vienna.

Khire, M., Benson, C. and Bosscher, P. (1994), Final Cover Hydrologic Evaluation, Phase III Report, Environmental Geotechnics Report 94-4, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Kim, K. and Benson, C. (2002), Water Content Calibrations for Final Cover Soils, Geo Engineering Report 02-12, Geo Engineering Program, University of Wisconsin-Madison.

Kleven, J., Edil, T., and Benson, C. (1998), Mechanical Properties of Excess Foundry Sand for Roadway Subgrade, Environmental Geotechnics Report 98-1 Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Klima, J., Edil, T., and Benson, C. (1996), Field Assessment of Monitoring and Water Supply Well Seals, Environmental Geotechnics Report 96-11, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Kosson, D., Salisbury, J., Powers, C., Benson, C., Bliss, L., Brown, K., Burger, J., Burkhardt, B., Clarke, J., Fyffe, L., Gochfeld, M., Higley, K., Hornberger, G., Jones, K., Krahn, S., LeBoeuf, E., Mayer, H., Stewart, R., and Turner, H. (2018), Hanford Site-Wide Risk Review Project - Final Report, Submitted to Department of Environmental Management, US Department of Energy, by Consortium for Risk Evaluation with Stakeholder Participation, Vanderbilt University, Nashville, TN.

Kosson, D., Garrabrants, A., Wang, X., Qui, Q., Chen, Z., DeLapp, R., van der Sloot, H., Benson, C., Chen, J., and Benavides, J. (2020), Leaching, Geotechnical, and Hydrologic Characterization of Coal Combustion Products from a Closed Coal Ash Impoundment, Report No. 3002017363, Electric Power Research Institute (EPRI), Palo Alto, CA.

Kraus, J. and Benson, C. (1994), Effect of Freeze-Thaw on the Hydraulic Conductivity of Three Paper Mill Sludges: Laboratory and Field Evaluation, Environmental Geotechnics Report 94-6, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Kraus, J. and Benson, C. (1994), Laboratory and Field Evaluation of the Effect of Freeze-Thaw on the Hydraulic Conductivity of Barrier Materials, Environmental Geotechnics Report 94-5, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Lane, D., Benson, C., and Bosscher, P. (1992), Hydrologic Observations and Modeling Assessments of Landfill Covers: Phase I-Final Report, Environmental Geotechnics Report 92-10, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Lau, A., Edil, T., and Benson, C. (2001), Use of Geocells in Flexible Pavements Over Poor Subgrades, Geo Engineering Report 01-05, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Lee, T. and Benson, C. (2002), Using Waste Foundry Sands as Reactive Media in Permeable Reactive Barriers, Geo Engineering Report 02-01, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Li, L., Benson, C. and Edil, T. (2005), Assessing Groundwater Impacts from Coal Combustion Products Used in Highways, Geo Engineering Report No. 05-22, Departmental of Civil and Environmental Engineering, University of Wisconsin-Madison.

Li, L., Eykholt, G., and Benson, C. (2001), Groundwater Modeling: Semi-Analytical Approaches for Heterogeneity and Reaction Networks, Groundwater Research Report WRI GRR 01-10, Water Resources Institute, University of Wisconsin-Madison.

Maxwell, S., Kim, W., Edil, T., and Benson, C. (2005), Effectiveness of Geosynthetics in Stabilizing Soft Subgrades, Report 0092-45-15, Wisconsin Highway Research Program, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Meer, S. and Benson, C. (2004), In-Service Hydraulic Conductivity of GCLs in Landfill Covers, Geo Engineering Report 04-17, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Meerdink, J. and Benson, C. (1994), Unsaturated Hydraulic Conductivity of Two Compacted Barrier Soils, Environmental Geotechnics Report 94-6, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Mengelt, M., Edil, T., and Benson, C. (2000), Reinforcement of Flexible Pavements Using Geocells, Geo Engineering Report 00-4, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Nelson, M. and Benson, C. (2002), Laboratory Hydraulic Conductivity Testing Protocols for Paper Industry Residuals Used for Hydraulic Barrier Layers, Technical Bulletin No. 848, National Council for Air and Stream Improvement, Research Triangle Park, NC.

Nelson, M. and Benson, C. (2002), Laboratory Hydraulic Conductivity Testing Protocols for Paper Sludges Used for Hydraulic Barriers, Geo Engineering Report 02-02, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Palmer, B., Benson, C., and Edil, T. (1997), Class F Fly Ash as a Barrier Material: Laboratory and Field Evaluation, Environmental Geotechnics Report 97-6, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Roesler, A., Benson, C., and Albright, W. (2002), Field Hydrology and Model Predictions for Final Covers in the Alternative Cover Assessment Program – 2002, Geo Engineering Report 02-08, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Russell, J., Benson, C. and Jeljeli, M. (1990), Use of Monte Carlo Techniques to Enhance Qualifier-1 Contractor Prequalification Model, Technical Report No. 102, Construction Engineering and

Management Program, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Samuelson, M. and Benson, C. (1997), Predicting Frost Depths Beneath Flexible Roadways Using a Thermal Model, Environmental Geotechnics Report 97-5, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Sauer, J., Benson, C. and Edil, T. (2005), Metals Leaching from Highway Test Sections Constructed with Industrial Byproducts, Geo Engineering Report No. 05-21, Departmental of Civil and Environmental Engineering, University of Wisconsin-Madison.

Sauer, J., Benson, C. and Edil, T. (2005), Leaching of Heavy Metals from Organic Soils Stabilized with High Carbon Fly Ash, Geo Engineering Report No. 05-01, Departmental of Civil and Environmental Engineering, University of Wisconsin-Madison.

Smith, C. and Benson, C. (2016), Influence of Coupling Erosion and Hydrology on the Long-Term Performance of Engineered Surface Barriers, NUREG/CR-7200, Office of Research, US Nuclear Regulatory Commission, Washington, DC.

Tatlisoz, N., Edil, T., Benson, C., Park, J., and Kim, J. (1996), Review of Environmental Suitability of Scrap Tires, Environmental Geotechnics Report 96-7, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Trast, J. and Benson, C. (1993), Hydraulic Conductivity of Thirteen Compacted Clays, Environmental Geotechnics Report 93-3, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Williams, M., Fuhrmann, M., Stefani, N., Michaud, A., Likos, W., Benson, C., and Waugh, W. (2022), Evaluation of In-Service Radon Barriers over Uranium Mill Tailings Disposal Facilities, NUREG/CR-7288, Office of Research, US Nuclear Reg. Comm., Washington, DC. Appx.

Yesiller, N., Edil, T., and Benson, C. (1994), Ultrasonic Evaluation of Cased Borehole Seals, Environmental Geotechnics Report 94-8, Dept. of Civil and Environmental Engineering, University of Wisconsin-Madison.

Yesiller, N., Edil, T., and Benson, C. (1994), Verification Technique to Evaluate the Integrity of Well Seals, Environmental Geotechnics Report 94-2, Department of Civil and Environmental Engineering, University of Wisconsin-Madison.

Standards

Benson, C. (2011), Standard D 6391, Standard Test Method for Field Measurement of Hydraulic Conductivity Using Borehole Infiltration, *Annual Book of Standards*, ASTM Intl., 04.09.

Benson, C. (2007), Standard D 7243, Standard Guide for Measuring the Saturated Hydraulic Conductivity of Paper Industry Sludges, *Annual Book of Standards*, ASTM Intl., 04.09.

Benson, C., Wang, X. and Kim, H. (2007), Standard D 6836, Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using a Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, and/or Centrifuge, *Annual Book of Standards*, ASTM Intl., 04.09.

Bradshaw, S., Scalia, J., Benson, C., and Rauen, T. (2010), Standard D 7503, Standard Test Method for Measuring the Exchange Complex and Cation Exchange Capacity of Inorganic Fine-Grained Soils, *Annual Book of Standards*, ASTM Intl., 04.09.

Daniel, D. and Benson, C. (2002), Standard D 5856, Test Method for Measurement of Hydraulic Conductivity of Porous Material Using a Rigid-Wall Compaction Mold Permeameter, *Annual Book of Standards*, ASTM Intl., 04.09. Originally approved 1995, Revised 2002.

Ladd, R. and Benson, C. (2000), Standard D 5084, Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter, *Annual Book of Standards*, ASTM Intl., 04.09. Extensive revision in 2000 by R. Ladd and C. Benson. Originally developed by J. Dunn and D. Daniel.

Yesiller, N., Shackelford, C., and Benson, C. (2005), Standard D 7100, Standard Test Method for Hydraulic Conductivity Compatibility Testing of Soils with Aqueous Solutions that may Alter Hydraulic Conductivity, *Annual Book of Standards*, ASTM Intl., 04.09.

SPONSORED RESEARCH

Environmental Containment Systems

Field and Laboratory Assessment of the Radon Barrier at the Mexican Hat, Utah Disposal Site, US Department of Energy, Office of Legacy Management, with W. Likos.

Understanding, Managing, and Preventing Clogging of Landfill Systems with Black Sticky Material, Environmental Research and Education Foundation.

Effectiveness of Landfill Liners to Control Transport of PFAS in Leachate, Environmental Research and Education Foundation.

Spatial and Temporal Correlation Between Physical and Chemical Odor Measurements and Odor Complaints, Advanced Disposal Services, with A. Benson.

Evaluation and Management of High-Moisture Waste Disposal in Municipal Solid Waste Landfills, Environmental Research and Education Foundation, with J. Scalia and C. Bareither (Colorado State University).

Geochemical Assessment of Long Term Leachate Quality and Impacts of Wastewater Management Practices at Coal Combustion Product (CCP) Disposal Facilities, Electric Power Research Institute, with D. Kosson (Vanderbilt University).

Water Balance Analysis and Data Quality Assurance Assessment for Monticello and Grand Junction Disposal Cell Lysimetry, Navarro Corporation and US Department of Energy.

Service Life of Bentonite-Polymer Geosynthetic Clay Liners, CETCO, Inc.

Behavior of Bentonite-Polymer Geosynthetic Clay Liners Permeated with Aggressive Leachates, CETCO, Inc., with W. Likos.

Evaluating the Long-Term Performance of the SDF Closure Cap, Savannah River Remediation, Inc. and US Department of Energy.

Understanding and Predicting Temperatures in Municipal Solid Waste Landfills, Environmental Research and Education Foundation, with M. Barlaz, NC State University.

Evaluating Effectiveness of Surface Covers for Controlling Water and Radon Fluxes at Uranium Mill Tailings Disposal Facilities, US Nuclear Regulatory Commission, with W. Likos.

Behavior of Polymer-Modified Bentonites Contacted with Aggressive Leachates, Colloid Environmental Technologies Corporation, with W. Likos.

Compatibility of Compacted Clay Liners and Leachate from CCP Containment Facilities, Electric Power Research Institute.

Compatibility of Geosynthetic Clay Liners and Leachate from CCP Containment Facilities, Electric Power Research Institute.

Bench-Scale Comparison of EVOH and HDPE Geomembranes as Barriers to VOC and Methane Emissions, Kuraray America Inc.

Consortium for Risk Evaluation and Stakeholder Participation, US Department of Energy, with Vanderbilt University, Rutgers University, New York University, Oregon State University, University of Pittsburgh, Howard University, University of Arizona, Robert Wood Johnson Medical School.

Coupling Effects of Erosion and Hydrology on the Long-Term Performance of Engineered Surface Barriers, US Nuclear Regulatory Commission

Predicting the Long-Term Performance of Surface Barriers for LLRW Containment, US Department of Energy, Consortium for Risk Evaluation with Stakeholder Participation

Effectiveness of Engineered Covers: From Modeling to Performance Monitoring, US Nuclear Regulatory Commission

Bentonite-Polymer Nanocomposites for Geoenvironmental Applications, National Science Foundation, with T. Edil and C. Shackelford

Prion Transport in Porous Media: Influence of Electrostatic and Non-DLVO Interactions, National Science Foundation, with J. Pedersen and J. Aiken

Effect of Stress, Hydration, and Ion Exchange on the Hydraulic Conductivity of Geosynthetic Clay Liners, Colloid Environmental Technologies Corporation

Innovative Methods for Natural Restoration of Final Covers for Mill Tailings, US Dept. of Energy, with W. Albright and J. Waugh

Evaluating Long-Term Impacts on Final Covers - Exhumation of the ACAP Test Sections, National Science Foundation, US Environmental Protection Agency, Environmental Research and Education Foundation, with D. Fratta and W. Albright

Toxin/Pathogen Inactivation and Disposal of Intentionally Contaminated Foods, National Center for Food Protection and Defense, US Dept. of Homeland Security, with D. Noguera

Predictive Tools for Sustainable Solid Waste Management Using Bioreactor Landfills, National Science Foundation, with M. Barlaz (*Bioreactor Partnership*)

The State of Municipal Solid Waste Bioreactor Landfills-II, US Environmental Protection Agency, with M. Barlaz

VOC Transport Through Composite Landfill Liners, Groundwater Research Advisory Council, State of Wisconsin, with T. Edil.

VOC Transport in Lined Containment Facilities, Groundwater Research Advisory Council, State of Wisconsin, with T. Edil.

Hydrology of the Monticello Water Balance Cover, Stoller Corporation and US Dept. of Energy.

Effect of Freeze Thaw on Compacted Soil Liners and Covers, University of Wisconsin Graduate School.

Fate and Transport of Chronic Waste Disease Prions in Municipal Solid Waste Landfills, US Environmental Protection Agency, with J. Pedersen and J. Aiken.

Evaluation of VOC Contamination of Groundwater from Lined Landfills in Wisconsin, Groundwater Research Advisory Council, State of Wisconsin.

Hydrologic Modeling of Covers Used for Mine Waste Containment, US Environmental Protection Agency, with C. Shackelford.

Bioreactor Landfills: State of the Practice, US Environmental Protection Agency, with D. Lane and M. Barlaz.

Field Performance of Alternative Covers, US Environmental Protection Agency.

Integrated Long-Term Stewardship for Low-Level Radioactive Waste, US Department of Energy and Flour Fernald, Fernald, Ohio.

Chemical Interactions Between Mine Waste Liquids and Geosynthetics, Groundwater Research Advisory Council, State of Wisconsin, with T. Edil.

Long-term Chemical Compatibility of Geosynthetic Clay Liners, National Science Foundation, with C. Shackelford.

Hydraulic Conductivity Testing Protocols for Paper Sludges, National Council of the Pulp and Paper Industry for Air and Stream Improvement.

Dry Barriers for Waste Containment, National Science Foundation, with S. Kung

Alternative Cover Assessment Program, United States Environmental Protection Agency, with W. Albright (Desert Research Institute) and Glendon Gee (Battelle PNNL).

Large-Scale Verification of a VOC Transport Model for Composite Liners, Groundwater Research Advisory Council, State of Wisconsin, with T. Edil.

Field Assessment of Geosynthetic Clay Liners in Final Covers, United States Environmental Protection Agency.

Unsaturated Hydraulic Properties of Alternative Cover Soils, Waste Management, Waste Connections, Bluestem Solid Waste Authority, and Marina Solid Waste Management District

Alternative Covers for Waste Containment in Southern California, San Bernardino County, CA.

Equivalency of Subtitle D and Alternative Earthen Covers, City of Glendale, Arizona.

Development of *Win*UNSAT-H, a Windows Implementation of UNSAT-H, WMX Technologies.

Hydraulic Characterization of Mine Rock Backfill for the Flambeau Mine, Flambeau Mining Company, Ladysmith, WI

Hydraulic Characterization of Mine Rock Backfill for the Flambeau Mine: II-In Situ Verification, Flambeau Mining Company, Ladysmith, WI

Field Hydraulic Conductivity Assessment of the NCASI Test Plots, National Council of the Paper Industry for Air and Stream Improvement

Effect of Freeze-Thaw on the Hydraulic Conductivity of Compacted Papermill Sludge, the National Council of the Paper Industry for Air and Stream Improvement.

Engineering Properties of Paper Sludges Used for Hydraulic Barriers in Landfill Covers, Solid Waste Research Program, State of Wisconsin.

Shear Strength of Municipal Solid Waste, WMX Technologies, Inc., with T. Edil.

Evaluating the Effectiveness of Landfill Liners, Groundwater Research Advisory Council, State of Wisconsin, with T. Edil.

Laboratory and Field Evaluation of the Effects of Freeze-Thaw on Barrier Materials, United States Environmental Protection Agency.

Field-Evaluation of Geoinsulation-A Geosynthetic Insulation Material, Envotech Limited Partnership, with P. Bosscher

Hydraulic Conductivity Assessment of Compacted Soil Liners, Waste Management of North America, Inc.

Rational Construction Quality Control Criteria for Compacted Soil Liners, University of Wisconsin Graduate School.

Final Cover Hydrologic Evaluation, Waste Management of North America, Inc.

Evaluation of Freezing and Thawing on the Hydraulic Conductivity of a Test Pad, Waste Management of Wisconsin, Inc.

Improved Design Methods for Landfill Final Covers, National Science Foundation.

Quality Assurance and Hydraulic Conductivity Assessment of Compacted Soil Liners, Waste Management of North America and Chemical Waste Management, Inc.

Hydrologic Analysis of a Co-Composting Landfill, Solid Waste Research Council, State of Wisconsin.

Sustainability and Sustainable Infrastructure

Center for Mineral and Metal Oxide Removal from Biomass (CMORE), Schmidt Sciences and the Foundation for Food & Agriculture Research, with Idaho National Laboratory, Iowa State University, University of Kansas, and Idaho State University.

Using Harvested Ash in Concrete and Cement Production, Electric Power Research Institute, Palo Alto, California.

Multi-University Center on Chemical Upcycling of Waste Plastics (CUWP), Office of Energy Efficiency and Renewable Energy US Department of Energy, with U. Wisconsin-Madison, U. Massachusetts, and Iowa State U.

Greenhouse Gas Emissions, Climate Change, and the Impacts of Climate Policy on the Global Coal Industry, Vigoris Coal Coalition LLP, Vancouver, BC.

Sustainability Assessment and Greenhouse Gas Implications of Envirocoal, Adaro Energy PT, Jakarta Indonesia.

Exchange Network for Expanded Polystyrene Bio-Shipping Containers, People, Prosperity, & Planet (P3) Program-Phase II, US Environmental Protection Agency

Exchange Network for Expanded Polystyrene Bio-Shipping Containers, People, Prosperity, & Planet (P3) Program-Phase I, US Environmental Protection Agency

Leaching from Roadways Constructed with Unencapsulated CCPs: Data Assessment & Synthesis, Electric Power Research Institute, with T. Edil.

Climate Change Mitigation and Adaptation in Dairy Production Systems of the Great Lakes Region, United States Department of Agriculture, National Institute of Food and Agriculture, with Matthew Ruark (PI) and others.

Recycled Materials Resource Center – Third Generation, Federal Highway Administration Pooled Fund, with T. Edil.

Recycled Materials Resource Center, Federal Highway Administration and United States Environmental Protection Agency, with K. Gardner

Environmental Benefits of Using Coal Combustion Products in Construction, Electric Power Research Institute, with T. Edil

Engineering Behavior of Recycled Unbound Materials, US Dept. of Transportation Pooled Fund, with T. Edil.

Assessing Environmental Impacts Associated with Bases and Subgrades Stabilized with Coal Combustion Products, Center for Freight and Infrastructure Research and Education, US Department of Transportation, with T. Edil.

User Guidelines for Waste and By-Product Materials in Highway Pavements, US Environmental Protection Agency, with A. Graettinger and J. Jambeck

Gravel Equivalency of Fly Ash Stabilized Reclaimed Roads, Minnesota Local Roads Research Board, with T. Edil

In Situ Stabilization of Gravel Roads with CCPs, Combustion Byproducts Recycling Consortium, US Dept. of Energy, with T. Edil

Leaching of Heavy Metals from Gray-Iron Foundry Slags Used in Geo Engineering Applications, Solid Waste Research Council, State of Wisconsin, with T. Edil.

Monitoring and Analysis of Leaching from Subbases Constructed with Industrial Byproducts, FHWA Recycled Materials Research Center, with T. Edil.

Ash Utilization in Low Volume Roads, Minnesota Department of Transportation, with T. Edil

Integrated Approach for Assessing Groundwater Impacts from Fly Ash Stabilized Soils, Alliant Energy, with T. Edil.

Geoenvironmental Assessment of Soft Soils Stabilized with High Carbon Fly Ashes, Solid Waste Research Program, State of Wisconsin, with T. Edil.

Are High Carbon Fly Ashes Effective Stabilizers for Soft Organic Soils?, National Science Foundation, with T. Edil.

Consortium for Beneficial Reuse of Fly Ashes, Alliant Energy, Northern States Power, and Mineral Solutions, Inc., with T. Edil.

Reuse of Fly Ash for Soil Stabilization, US Dept. of Energy, with T. Edil.

Field Demonstration of Earth Structures Constructed with Soil-Tire Chip Mixtures, Solid Waste Research Council, State of Wisconsin, with T. Edil.

Use of Foundry Sands in Hot Mix Asphalt, University Industrial Relations, with H. Bahia

Fly Ash Stabilization of Soft Subgrades, US Dept. of Energy, Mineral Solutions, Inc., and Alliant Power, with T. Edil.

Field Demonstration of Beneficial Reuse of Foundry Byproducts in Highway Subgrade, Wisconsin Department of Transportation, with T. Edil.

Properties of Foundry Sand Relevant to Design of Embankments and Retaining Wall Backfill, State of Wisconsin, Recycling Market Development Board, with T. Edil.

National Practice Survey: Beneficial Re-use of Waste Foundry Sands, State of Wisconsin Recycling Market Development Board, with T. Edil.

Using Waste Foundry Sands as Hydraulic Barriers, Solid Waste Research Council, State of Wisconsin, with T. Edil.

Field Assessment of Barrier Layers Constructed with Foundry Sands, Solid Waste Research Council, State of Wisconsin, with T. Edil.

Use of Shredded Waste Tires in Highway Construction, United States Environmental Protection Agency, with T. Edil.

Sub-base Replacement with Waste Foundry Sands, State of Wisconsin, Recycling Market Development Board, with T. Edil.

Using High Carbon Class F Fly Ash as a Lining Material: I-Laboratory Study, Solid Waste Research Council, State of Wisconsin, with T. Edil.

Using High Carbon Class F Fly Ash as a Lining Material: II-Field Verification, Solid Waste Research Council, State of Wisconsin, with T. Edil.

Reinforcement of Soils with Shredded Waste Tires, Solid Waste Research Council, State of Wisconsin, with P. Bosscher.

Use of Reclaimed Waste HDPE as Soil Reinforcement, Solid Waste Research Council, State of Wisconsin.

Groundwater

Leaching and Mobility of Per and Polyfluoroalkyl Substances (PFAS) from Concrete and Asphalt, Strategic Environmental Research and Development Program, US Dept. of Defense, with J. Guelfo and D. Kosson.

Sorption and Transport of Polycyclic Aromatic Hydrocarbons in Organoclays used for Permeable Adsorptive Barriers, CH2M Hill Inc. and Union Pacific Inc.

Environmental Impacts of Engineered Nanomaterials, Nanoscale Science and Engineering Center, National Science Foundation, with J. Pedersen and R. Hammers

Gray-Iron Foundry Slags as a Reactive Medium for Removing Arsenic from Ground Water and Drinking Water, Groundwater Research Advisory Council, State of Wisconsin, with D. Blowes.

Innovative Treatment of COPR Wastes in Coastal Areas, US Dept. of Transportation, with T. Edil.

Development of Large-Scale Application for Remediation of Chromium Ore Processing Residue, University Industrial Relations, University of Wisconsin, with T. Edil.

An Integrated Approach to Evaluating Environmental Impacts from Soils Stabilized with Fly Ashes, State of Wisconsin Recycling Program and Alliant Energy, Inc.

Uncertainty Based Design of Permeable Reactive Barriers, Wisconsin Ground Water Research Advisory Council, with G. Eykholt

Innovative Groundwater Treatment: Reactive Walls Constructed with Excess Foundry Sand, Wisconsin Groundwater Research Advisory Council, with G. Eykholt.

Development of Integrated Decision Support System for Wellhead Protection, Wisconsin Water Resources Council, State of Wisconsin.

Reducing Uncertainty in Subsurface Characterization, U.S. Department of Energy.

Ultrasonic Probe to Evaluate the Integrity of Borehole Seals, Federal Highway Administration, with T. Edil.

Field Assessment of Monitoring Well Seal Integrity, Groundwater Research Advisory Council, State of Wisconsin, with T. Edil.

A Tool for Evaluating the Integrity of Monitoring Well Seals, Groundwater Research Advisory Council, State of Wisconsin, with T. Edil.

Characterization of Air Plumes and Modeling Mass Removal During In Situ Air Sparging, Groundwater Research Advisory Council, State of Wisconsin, with G. Eykholt.

Education

Wisconsin-Puerto Rico Partnership for Research and Education in Materials [Wi(PR)EM], US National Science Foundation, with J. de Pablo, J. Pedersen, et al.

A Modular Geoenvironmental Curriculum, National Science Foundation, with other faculty from Wisconsin, Northwestern, Michigan, and Argonne National Laboratory.

Research Experience for Undergraduates Site, Geothermal and Energy Geotechnics, National Science Foundation, with J. Tinjum (PI), D. Fratta (co-PI), and S. Bradshaw.

Transforming CEE/GLE 330, Soil Mechanics, to Blended Learning, Division of Continuing Studies, University of Wisconsin-Madison.

Other Topics

Wisconsin Highway Research Program, Wisconsin Department of Transportation, with T. Edil.

Fate and Transport of Chronic Waste Disease Prions in Waste Water Treatment Plants, US Environmental Protection Agency

Stiffness and Stress State in Unsaturated Soils, Minnesota Department of Transportation, with T. Edil.

Thermal Conditions Below Highway Pavements During Winter, Wisconsin Department of Transportation, with P. Bosscher.

Design Protocols for Cellular Confinement with Geoweb, University Industrial Relations and Presto Products, Appleton, WI, with T. Edil.

Equivalency of Subgrade Improvement Methods, Wisconsin Department of Transportation, with T. Edil.

Reinforcement of Soft Subgrades with Geosynthetics, Wisconsin Department of Transportation, with T. Edil.

Evaluation of the DCP and SSG for Subgrade Evaluation, Wisconsin Department of Transportation, with T. Edil.

Shear Strength of Granular Backfill Materials, Wisconsin Department of Transportation, with T. Edil.

Correlating Index Properties and Engineering Behavior of Wisconsin Soils, Wisconsin Department of Transportation, with T. Edil.

Incorporating Alternative Subgrade Improvement Methods in Pavement Design, Wisconsin Department of Transportation, with T. Edil.

STEM TEACHER ENGAGEMENT

The following STEM teachers have been engaged in our research and educational programs through NSF's *Research Experience for Teachers* (RET) program:

Hayden, Matthew, Earth Science Teacher, Glacier Creek Middle School, Middleton-Cross Plains School District, Middleton, Wisconsin.

Kisting, Richard, Science Teacher, Badger Ridge Middle School, Verona Area School District, Verona, Wisconsin.

GRADUATE STUDENTS SUPERVISED

PhD Students

Abichou, T., Hydraulic Properties of Foundry Sands, co-advised with T. Edil, 1999.

Albrecht, B., Passive Dry Barriers: Air Circulation and Mass Transfer, 2001.

Albright, W., Field Performance of Landfill Covers, 2005.

Apiwantragoon, P., Alternative Covers: Field Performance and Modeling Methods, 2007.

Bareither, C., Settlement of Bioreactor Landfills: Compression Mechanisms, co-advised with T. Edil, 2010.

Breitmeyer, R., Unsaturated Hydraulic Properties of Solid Waste and Hydrology of Bioreactor Landfills, co-advised with T. Edil, 2010.

Bin-Shafique, S., Leaching of Heavy Metals from Fly Ash Stabilized Soils, co-advised with T. Edil, 2002.

Chalermyanont, T., Reliability Analysis of Mechanically Stabilized Earth (MSE) Walls, 2002.

Chang, P., Geophysical Characterization of Water and Solute Movement in an Arid Climate, 2003, co-advised with D. Alumbaugh.

Chen, J., Chemical Interactions between Coal Combustion Products and Geosynthetic Clay Liners, 2015.

Elder, C., Effect of Heterogeneity on Performance of Permeable Reactive Barriers, 2000.

Eun, J., Diffusive Transport of Organic Compounds in Liquid and Gas Phases through Co-Extruded EVOH Geomembranes, with J. Tinjum, 2014.

Foose, G., Leakage Rates and Chemical Transport Through Composite Landfill Liners, co-advised with T. Edil, 1997.

Gulec, S., Compatibility of Geosynthetics and Mine Waste Liquids, co-advised with T. Edil, 2003.

Gustitus, S. Accelerated Degradation and Service Life Prediction of Bentonite-Polymer Composite GCLs, 2021.

Hunter, E., Sorption of Radionuclides in Engineered Barrier Materials, with J. Tinjum, 2014.

Jo, H., Fundamental Factors Affecting Interactions Between Bentonite and Inorganic Liquids, 2003.

Khire, M., Field Hydrology and Water Balance Modeling of Earthen Final Covers for Waste Containment, 1995.

Kim, H., Oxygen Transport Through Multi-Layer Caps Over Mine Waste, 2000.

Kim, W., Alternative Subgrades Stabilization with Geosynthetics, co-advised with T. Edil, 2003.

Komonweeraket, K., Mechanisms Controlling Release of Trace Elements from Soils Stabilized with Fly Ash, co-advised with T. Edil, 2010.

Lee, T., Using Waste Foundry Sands as Reactive Media in Permeable Reactive Barriers, 2002.

Li, L., Impacts of Mineralogical Fouling of Permeable Reactive Barriers in Heterogeneous Environments, 2004.

Nokkaew, K., Unsaturated Hydraulic Behavior of Recycled Base Course Materials, co-advised with J. Tinjum, 2014

Othman, M., Effect of Freeze/Thaw on the Structure and Hydraulic Conductivity of Compacted Clays, 1992.

Park, M., Transport of VOCs in Composite Landfill Liners, co-advised with T. Edil, 2011.

Scalia, J., Bentonite-Polymer Nanocomposites for Environmental Containment, 2012.

Tachavises, C., Flow Rates Past Vertical Groundwater Cut-Off Walls: Influential Factors and Their Impact on Wall Selection, 1998.

Tanyu, B., Equivalency of Alternative Subgrade Stabilization Methods, co-advised with T. Edil, 2003.

Tian, K., Life Expectancy of Geomembranes Used in Low-Level Radioactive Waste Containment, 2015.

Tinjum, J., Innovative Remedial Treatment of Chromium Ore Processing Residues, co-advised with T. Edil, 2006.

Yesiller, N., Ultrasonic Evaluation of Cased Borehole Seals, 1994, co-advised with T. Edil.

Yu, T., Effect of PFAS on Effectiveness of Landfill Liner Systems, 2023, in progress.

MS Students

Abichou, T., Field Evaluation of Geosynthetic Insulation for Protection of Clay Liners, 1993.

Abu Hassanein, Z., Using Electrical Resistivity Measurement as a Quality Control Tool for Compacted Clay Liners, 1994.

Acosta, H., Stabilization of Soft Subgrade Soils Using Fly Ash, with T. Edil, 2002.

Albrecht, B., Effect of Desiccation on Hydraulic Conductivity of Compacted Clays, 1995.

Akpinar, M., Interface Shear Strength of Geomembranes and Geotextiles at Different Temperatures, 1997.

Bahner, E., Soil Nailing Case Histories in Wisconsin, 1993.

Baker, D., Physical Modeling of In Situ Air Sparging, 1996.

Bareither, C., Geological Controls on the Shear Strength of Wisconsin Sands, with T. Edil, 2006.

Basantis, A., Hydraulic Properties of Sluiced Coal Ashes, 2021.

Bashel, M., Flow Rates in Composite Landfill Liners, 1993.

Baugh, J., Fly Ash Stabilization of Gravelly Soils, with T. Edil, 2008.

Benavides, J. Marie, Hydrologic Predictions for Coal Combustion Products Disposal Facilities, did not finish thesis.

Beuermann, S., Dielectric Sensor for Measuring Suction in Dry Soils, 1999.

Bohnhoff, G., Predicting the Water Balance of Alternative Covers Using UNSAT-H, 2005.

Bozyurt, O., Effect of Deleterious Materials on the Mechanical Properties of RAP and RCA, with T. Edil, 2011.

Bradshaw, S., Effects of Stress, Hydration, and Ion Exchange on Geosynthetic Clay Liners, 2008.

Bridstrup, J., Transport of Polyfluorinated Compounds Through Engineered Barrier Materials, 2020.

Brown, B., Leaching of Trace Elements from Roadways Constructed with CCPs, 2015.

Camacho, L., Analysis of Landfill Failure Using Three-Dimensional Limit Equilibrium Methods, with T. Edil, 2002.

Camargo, F., Equivalency of Fly-Ash Stabilized RPM and Gravel Base Course, with T. Edil, 2008.

Chen, C., Meteorological Conditions for Design of Monolithic Alternative Earthen Final Covers (AEFCs), 1999.

Chiang, I., Effect of Fines and Gradation on Soil Water Characteristic Curves of Sands, 1998.

Christman, M., Annular Well Seals: A Geophysical Study of Influential Factors and Seal Quality, with T. Edil, 1999.

Cope, D., Treating TCE-Contaminated Groundwater with Gray-Iron Slag, 2007.

Cooper, S., An Evaluation of How Subsurface Characterization Using Soil Classifications Affects Predictions of Containment Transport, 1993.

Dingrando, J., Beneficial Reuse of Foundry Sands in Controlled Low Strength Material, with T. Edil, 1999.

Eberhardt, M., Leaching of Heavy Metals from Gray-Iron Slags with and without Carbonation, 2008.

Elder, C., Modeling Mass Transfer During In Situ Air Sparging, 1996.
Foose, G., Shear Strength of Sand Reinforced with Shredded Waste Tires, 1993.
Gavin, M., Physical and Chemical Effects of Electroosmosis on Kaolinite, with T. Edil, 1997.
Genthe, D., Shear Strength of Two Pulp and Paper Mill Sludges with Low Solids Content, 1993.
Gibson, S., Geoelectric Methods to Evaluate Borehole Seals, with T. Edil, 1999.
Goodhue, M., Reuse of Foundry Sands in Reinforced Earthen Structures, with T. Edil, 1998.
Gurdal, T., Unsaturated Hydraulic Properties of Alternative Cover Soils, 2003.
Hardianto, F., Representative Sample Size for Hydraulic Conductivity of Compacted Clay, 1993.
Harrick, M., Permeable Reactive Walls in Wisconsin, 1994.
Hill, T., Field and Laboratory Hydraulic Conductivity of Compacted Mine Waste Rock, 1997.
Jo, H., Chemical Compatibility of Non-Prehydrated GCLs and Inorganic Liquids, 1999.
Jong, D., Load Limit Timings for Roadways Exposed to Frost, 1997.
Kim, K., Water Content Reflectometer Calibrations for Final Cover Soils, 2002.
Kircher, J., Modeling Chemical and Physical Effects of Electro-osmosis on Kaolinite, with T. Edil, 1997.
Klett, N., Evaluation of VOC Discharges to Groundwater from Engineered Landfills in Wisconsin, with T. Edil, 2005.
Kolstad, D., Hydraulic Conductivity and Ion Exchange in GCLs Permeated with Multispecies Inorganic Solution, 2000.
Kleven, J., Mechanical Properties of Excess Foundry System Sand and an Evaluation of its use in Roadway Structural Fill, with T. Edil, 1997.
Klima, J., Field Assessment of Monitoring and Water Supply Well Seals, with T. Edil, 1996.
Kraus, J., Hydraulic Conductivity of Papermill Sludges, 1994.
Kucukkirca, I., In-Service Properties of Geosynthetic Materials Exhumed from Landfill Final Covers, with J. Tinjum, 2009.
Lanier, A., VOC Transport in Geosynthetic Clay Liners, 2002.
Lane, D., Hydrologic Observations and Modeling Assessments of Landfill Covers, 1992.
Lau, W., Use of Geocells in Flexible Pavements Over Poor Subgrades, with T. Edil, 2001.
Lee, T., Physical Modeling of Vertical Groundwater Cut-Off Walls, 1999.
Lin, L.C., Effect of Wet-Dry Cycling on Swelling and Hydraulic Conductivity of Geosynthetic Clay Liners, 1998.
Marchesi, I., Simulating the Hydrology of Alternative Covers with *SoilCover*, 2002.
Maxwell, S., Geosynthetic Reinforcement of Soft Subgrades, with T. Edil, 1999.
Meer, S., Effects of Ion Exchange and Desiccation on GCLs used in Final Covers, 2003.
Meerdink, J., Unsaturated Hydraulic Conductivity of Barrier Soils Used for Final Covers, 1994.
Mengelt, M., Effect of Cellular Confinement on Soil Stiffness Under Dynamic Loads, with T. Edil, 2000.
Mergener, E., Assessing Clogging of Permeable Reactive Barriers in Heterogeneous Aquifers Using a Geochemical Model, 2002.
Metz, S., Gray-Iron Slags as a Reactive Medium for Arsenic Treatment, 2007.
Nelson, M., Laboratory Hydraulic Conductivity Testing Protocols for Paper Sludges in Barrier Layers, 2001.
Olson, R., Source and Prevention Strategies for Black Goo in Landfills, Summer 2023.
Palmer, B., High Carbon Class F Fly Ash for Reactive Barrier Landfill Liners, with T. Edil, 1995.
Payne, L., Use of Pulsating Electro-Osmosis in Barrier Applications, with T. Edil, 1995.
Rauen, T., Effect of Bioreactor Leachate on Geosynthetic Clay Liners, 2007.
Pekarun, O., Evaluation of Hydraulic Significance of Defects in Annular Well Seals, with T. Edil, 1994.

Rochford, W., Effectiveness of Geomembrane and Soil-Bentonite Cut-Off Walls, 2002.

Roesler, A., Field Hydrology and Model Predictions for Final Covers in the Alternative Assessment Program, 2002.

Rosa, M., Effect of Freeze-Thaw Cycling on Resilient Modulus of Fly-Ash Stabilized Subgrade Soils, with T. Edil, 2006.

Sauer, J., Leaching of Heavy Metals from Organic Soils Stabilized with High Carbon Fly Ashes, with T. Edil, 2005.

Sajjad, M., Effect of Electro-Osmosis on Hydraulic Conductivity of Compacted Clay, 1993.

Scalia, J., Hydraulic Conductivity of Geosynthetic Clay Liners Used in Composite Final Covers, 2009.

Schlicht, P., Weathering-Induced Alterations in the Hydraulic Properties of Final Covers for Waste Containment, with J. Tinjum, 2009.

Setz, M., Ammonia exchange in Na-Bentonites Used for Waste Containment, 2013.

Simon, D., Comparison of Three Geophysical Imaging Techniques for Characterization of an IAS Plume, with D. Alumbaugh, 2001.

Smith, C., Coupling Hydrology and Erosion Control Design for Final Covers for Low-Level Radioactive Waste Containment, 2011.

Stefani, Nicholas, Field Evaluation of Radon Flux from Historic Uranium Mill Tailings Disposal Facilities, 2016.

Suwansawat, V., Using TDR for Moisture Movement in Clays, 1997.

Tan, Y., PFAS Transport through Engineered Barriers for Waste Containment, Webinr2024.

Tastan, O., Stabilizing Organic Soils with High Carbon Fly Ashes, with T. Edil, 2005.

Tatlisoz, N., Using Tire Chips in Earthen Structures, with T. Edil, 1995.

Thorstad, P., Field Performance of a Geosynthetic Clay Liner (GCL) Used as the Hydraulic Barrier Layer in a Landfill Cover in Southwestern Wisconsin, 2002.

Tian, K., Leachate Chemistry and Geomembrane Durability in Low-Level Radioactive Waste Containment, 2012.

Trast, J., Field Hydraulic Conductivity of Thirteen Compacted Clay Liners, 1993.

Tinjum, J., Soil Water Characteristic Curves for Compacted Fine Grained Soils, 1995.

Trzebiatowski, B., Effect of Pedogenesis on Soil Water Characteristic Curves of Cover Soils, 2004.

Vasko, S., Hydraulic Conductivity of Prehydrated Geosynthetic Clay Liners Permeated with Calcium Chloride Solutions, 1999.

Wang, X., Evaluating Suction Head at the Wetting Front During Infiltration in Compacted Clays, 1993.

Williams, Thomas, Engineering Properties of a Composite Barrier System Exposed for a Decade, 2018.

Winkler, W., Thickness of Monolithic Covers in Arid and Semi-Arid Climates, 1999.

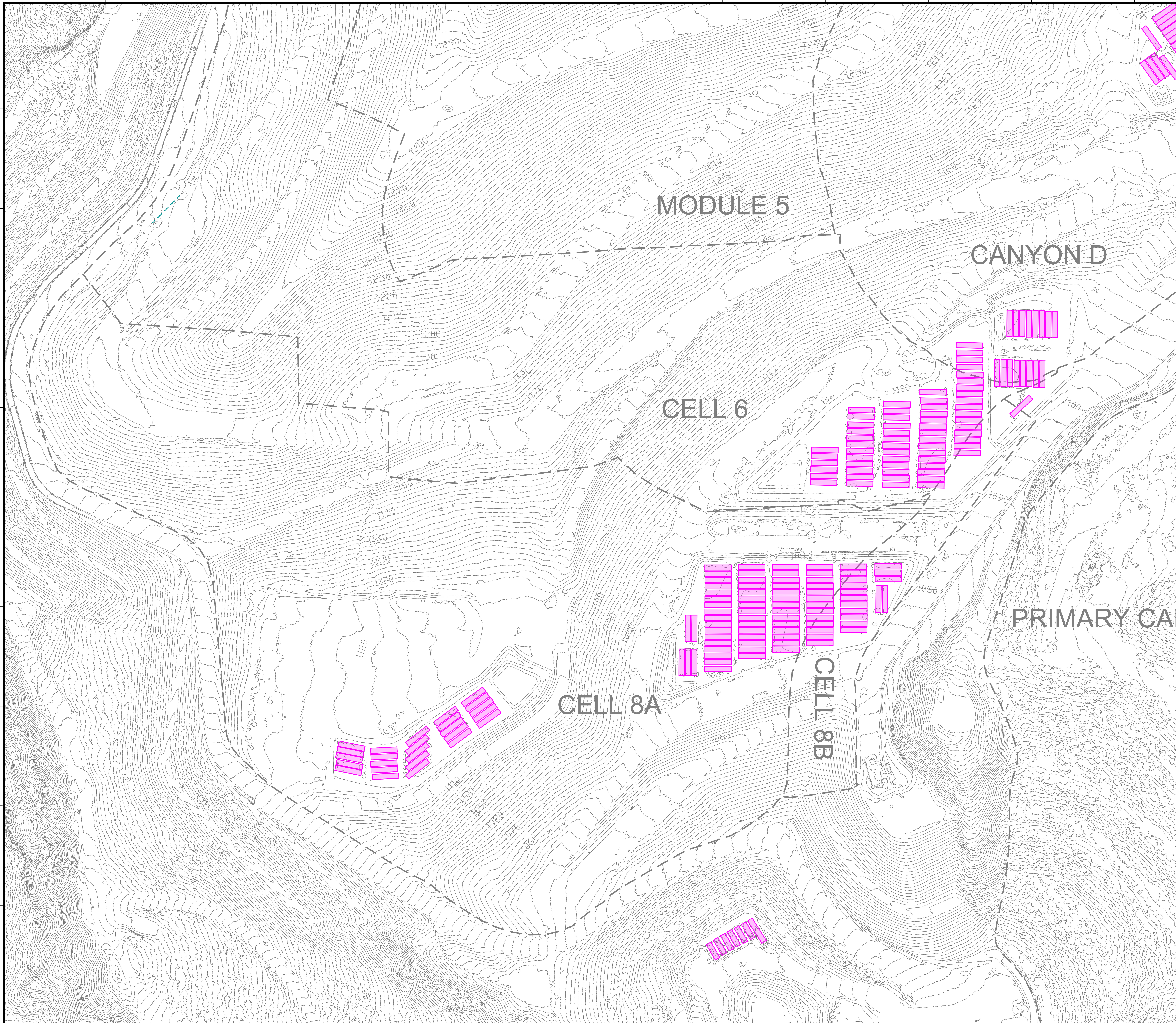
Woodward, N., Life Expectancy of Geosynthetic Materials Used in Low-Level Radioactive Waste Containment, with J. Tinjum, 2011.

Zangl, F., Impact of Cyclic Dehydration on Bentonite-Polymer Nanocomposites Used for Waste Containment, with W. Likos, 2014.

EDITORSHIPS

Editor-in-Chief, ASCE *Journal of Geotechnical and Geoenvironmental Engineering,* 2004-2006
Editor, ASCE *Journal of Geotechnical and Geoenvironmental Engineering,* 1996-99
Editorial Board, *Journal of Geotextiles and Geomembranes,* 2009-2021.
Editorial Board, *Environmental Geotechnics J.,* 2014-2021.
Editorial Board, *Coal Combustion and Gasification Products J*., Asst. Editor, 2017-present.
Co-Editor, *Waste Containment and Remediation*, GSP No. 142, ASCE, A. Alshawabkeh et al., co-editors, 2005.
Editor, *Risk-Based Corrective Action and Brownfields Restorations*, GSP No. 82, ASCE, J. Meegoda, R. Gilbert, and S. Clemence, co-editors, 1998
Co-Editor, Environmental Geotechnics Section, *Geotechnical News,* 1994-1996
Co-Editor, Special Issue on Innovations in Solid Waste Engineering and Management: The 2008 Global Waste Management Symposium, *J. of Environmental Engineering*, M. Barlaz, co-editor, 136(8), 2010.

ATTACHMENT C



LEGEND

1150	EXISTING TOPOGRAPHIC MAP
	EXISTING CELL LIMITS (APPROXIMATE)
	EXISTING FRAC TANK

GENERAL DRAWING NOTES:

1. EXISTING TOPOGRAPHIC SURVEY INFORMATION SHOWN WAS PROVIDED BY PROPELLOR. AERIAL PHOTOGRAPHY DATED NOVEMBER 12, 2025.
2. NORTH ARROW SHOWN HERE IS REFERENCE TO THE CALIFORNIA STATE PLANE ZONE V COORDINATE SYSTEM, NAD 83.

NO.	REVISION	DATE

SHEET TITLE: TANK FARM 13

PROJECT TITLE: CHIQUITA CANYON LANDFILL CASTAIC, CALIFORNIA

CLIENT: CHIQUITA CANYON LANDFILL CASTAIC, CALIFORNIA

SCS ENGINEERS
ENVIRONMENTAL CONSULTANTS
3900 KILROY AIRPORT WAY, SUITE 300
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PROJ. NO. 01204123.41	DWN. BY: SRM	ACAD FILE: F:/ENGINEERS
DSN. BY: -	CHK. BY: -	APP. BY: -

DATE: 11/19/2025

SCALE: AS SHOWN

SHEET: 1

ATTACHMENT D

Evaluation of Reaction Caused Surface Settlement:

May 18, 2023, through May 21, 2025

Prepared For:

CHIQUITA CANYON LANDFILL

September 15, 2025

Blue Ridge Services Montana, Inc.
P.O. Box 1945
Hamilton, MT 59840
Telephone: (406) 370-8544

CONTENTS

ACRONYMS

Acronym	Meaning
AQMD	South Coast Air Quality Management District
BRS	Blue Ridge Services Montana, Inc.
CCL	Chiquita Canyon Landfill
ETLF	Elevated Temperature Landfill
GCCS	Gas Collection and Control System
LFG	Landfill Gas
MSW	Municipal Solid Waste
RA-AQMD	Reaction Area as defined by AQMD
RA-Data	Reaction Area as defined by Reaction Committee using Data
SEM	Surface Emission Monitoring for Landfill Gas

BACKGROUND

The Chiquita Canyon Landfill (CCL or Landfill) is a municipal solid waste (MSW) landfill located in northern Los Angeles County. A portion of the Landfill is experiencing a subsurface reaction also known as an Elevated Temperature Landfill (ETLF) event. While all landfills experience surface settlement due to normal decomposition of waste, ETLF events cause accelerated decomposition often resulting in increases to a landfill's settlement rate, heat generation, and liquid levels.

Chiquita continues to diligently monitor the status of the reaction, particularly in terms of its location and whether it is expanding laterally. Simultaneously, CCL continues its efforts to mitigate the effects of the ETLF event, by extracting landfill gas (LFG) and leachate from within and around the RA-Data at unprecedented rates.

While there are many criteria used to delineate the physical boundary of the reaction, this Surface Settlement Study addresses one of them – settlement.

This Surface Settlement Study was conducted by Blue Ridge Services Montana, Inc. (BRS), under the direction of Neal Bolton, P.E. Mr. Bolton is president of Blue Ridge Services Montana, Inc. (BRS) and is a national expert in landfill operations. He serves on the Reaction Committee as the subject matter expert in landfill design and operational best management practices pursuant to Condition No. 12(a)(i) of the Stipulated Order for Abatement with the South Coast Air Quality Management District (AQMD) in Case No. 6177-4 (SOFA). He has provided various consulting support to Chiquita since 2020, including being part of the consulting team that resolved the working face odor issue in 2022. Additionally, he has broad operational experience within the heavy construction and solid waste industry that spans more than 47 years, during which time he has provided operational support for more than 500 landfills throughout North America and abroad.

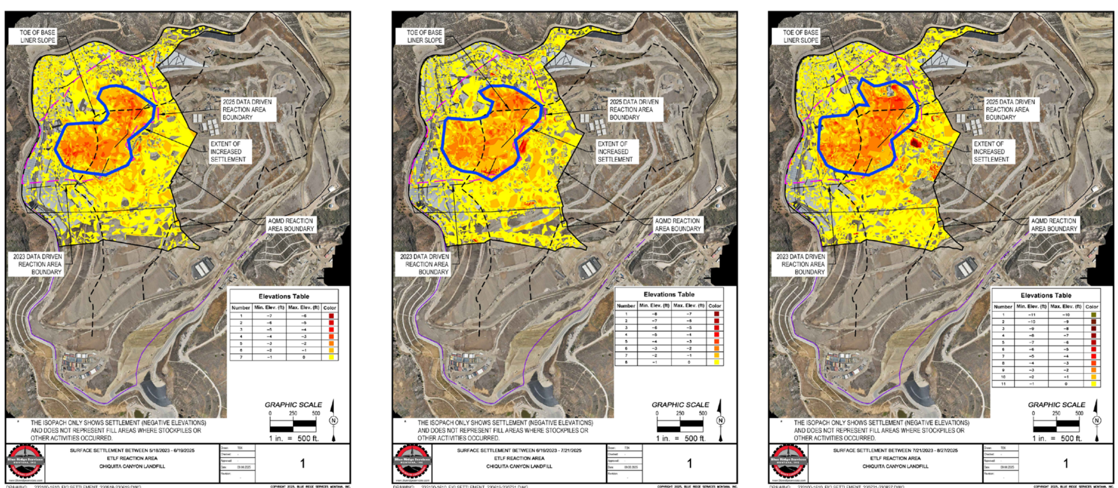
In this report, BRS analyzed surface settlement at CCL over a 2-year period between May 18, 2023, and May 21, 2025. The start date of May 18, 2023, was chosen because that date was the earliest date with Propeller[1] drone mapping data where no MSW fill activity occurred within the RA-Data of the Landfill. All subsequent fill activity was limited to reaction mitigation efforts involving the placement of cover material, re-grading, material stockpiling, and localized construction.

EXECUTIVE SUMMARY

There were two primary goals of this study. The first was to identify areas of accelerated settlement that can be directly attributed to the ETLF event. The second was to quantify the rate of change of settlement to ascertain if the reaction is accelerating or decelerating vertically and/or laterally - and if so in what direction(s).

The results of this settlement study indicate that the reaction is slowing. Initially, in early 2023, the rate of change in terms of settlement was increasing – it was accelerating. This acceleration was a clear and obvious indicator that the subsurface reaction was occurring. At its peak, settlement within the RA-Data was occurring at an annualized rate of nearly 8% per year. Please note that we have expressed this at an annual rate, even though the period of peak acceleration lasted only a few months.

The location of the rapidly accelerating settlement was first observed within the eastern third of the current RA-Data as defined by the Reaction Committee. This acceleration is shown by the areas outlined by the blue line in the following three isopach's (See Figure 1). This shows the accelerated



May-June 2023 **June-July 2023** **July-August 2023**

Initial Reaction Settlement

Figure 1

[1] Propeller is a third-party service provider of onsite drone mapping equipment and software. CCL utilizes Propeller to provide high quality topographic mapping of the Landfill's surface on an as-needed basis.

settlement that occurred during the first three months from the start of our 2-year analysis. This appears to show the general starting area of the reaction.

As seen in Figure 1, the reaction was progressively expanding mostly to the west and northwest. This was supported by field evidence of high liquid levels, elevated temperatures, and general highly decomposed waste characteristics observed in drilling spoils and material excavated during the West Toe Project and the North Slope Termination Project.

While the rate of change of settlement across the northwest portion of CCL increased above baseline, the highest rate of change occurred within the red-shaded RA-Data boundary. Accelerated settlement rates were also observed in the adjacent area within the tan-shaded AQMD defined reaction area (RA-AQMD), but the rates were not as high as within RA-Data (See Figure 2). For reference, these two areas, along with the non-reaction area green-shaded area.

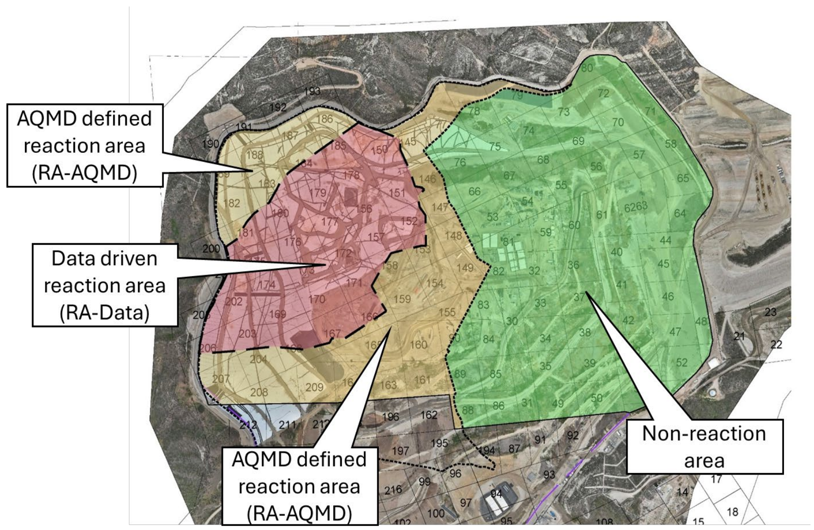


Figure 2

Our settlement analysis indicates that areas adjacent to the RA-Data boundary also showed increased settlement due to collateral impacts of the reaction. These collateral impacts include the lateral migration of heat, LFG, and leachate that is being generated by the reaction. However, the rate of settlement in those adjacent areas is much less than was observed within the RA-Data. Accordingly, it is important to note that while above normal settlement is still occurring within and adjacent to the RA-Data boundary, the rate of change over time is slowing – it is decelerating.

These charts (See Figure 3) show the average annualized rate of change of settlement within the RA-Data and RA-AQMD respectively (See the right-hand vertical axis on each chart). The months with the highest rate of change within RA-Data were March 2024 and December 2024 when annualized settlement approached 8%.

As simply a point of reference, both charts show the daily rate of settlement and the annualized – or yearly – rate of settlement.

It is important to note the trendline for the changing rate of settlement. In both cases, the trendline reached its peak in September 2024 and has since been declining. This diminishing rate of settlement indicates that the reaction is slowing, rather than expanding. This also implies that CCL's efforts related to liquid and gas removal are effective in mitigating the reaction.

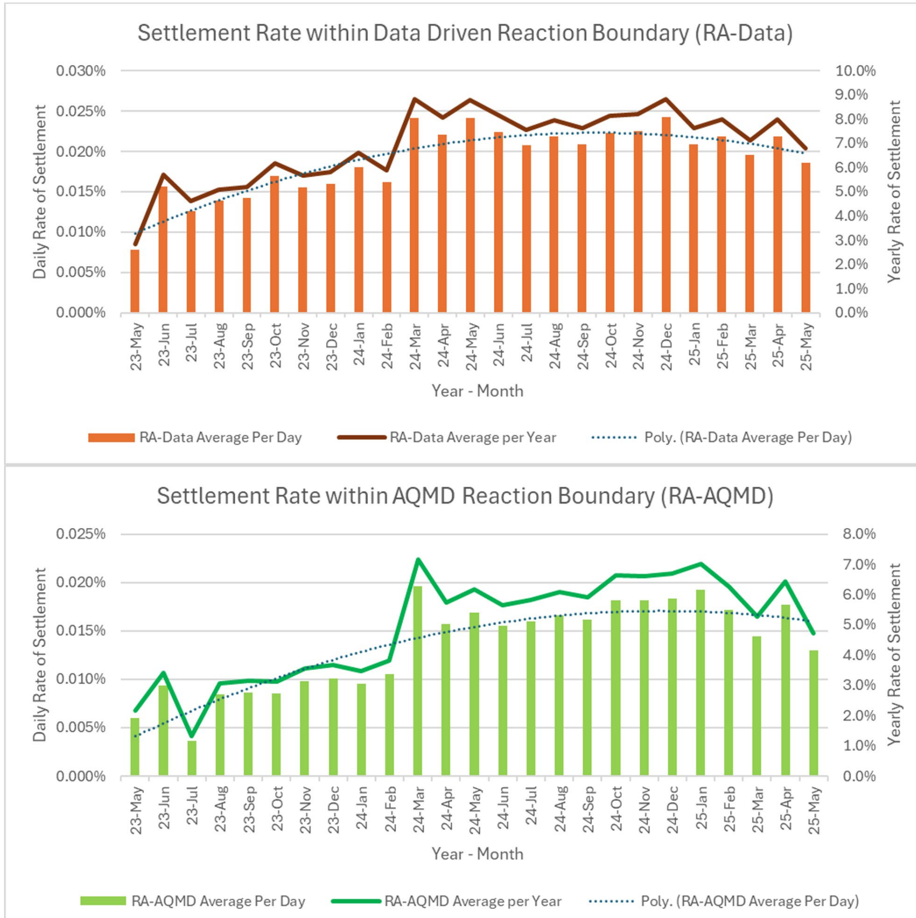


Figure 3

As evidenced by the combined data (See Figure 4), the RA-Data area has always exhibited a faster rate of settlement, which is expected in the portion of Landfill that is experiencing the ETLF event. The surrounding area, the RA-AQMD area, by nature of being in proximity to the RA-Data area, also experienced increased settlement prior to September 2024.

However, as noted by the data, the rate of change of settlement in the RA-AQMD area has always been substantially slower than that in the RA-Data

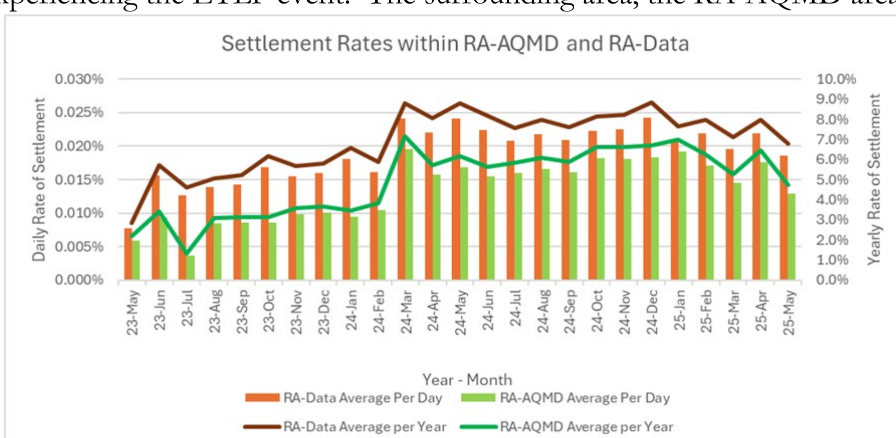
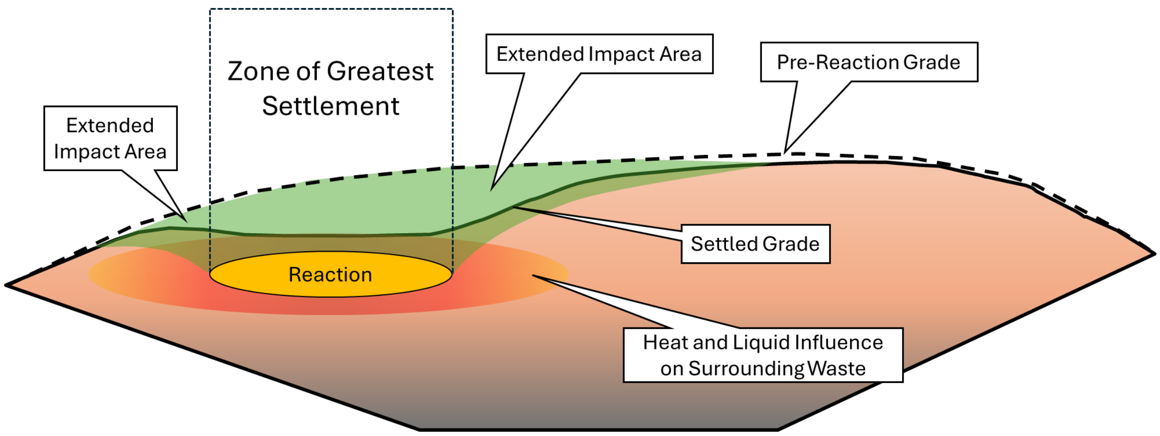


Figure 4

area, demonstrating the difference between the true area of CCL being impacted by the reaction and the areas adjacent thereto.

Settlement in the areas adjacent to the RA-Data area is likely caused by the effect of the reaction where the waste mass in proximity to it is influenced by the collapse of the subsurface reaction area and shown here as the zone of greatest settlement. Adjacent settlement is also attributed to the lateral transfer of LFG, heat, and liberated leachate that radiates outward from the RA-Data (See Figure 5).

In summary, while settlement is evident outside the RA-Data boundary, it has been observed at the same rate as within the RA-Data area. More importantly, the rate of settlement across the northwest portion of the Landfill is slowing – it is decelerating.



Conceptual Impact on Surrounding Waste

Figure 5

GOALS

There were two primary goals of this study. The first was to identify areas of accelerated settlement that can be directly attributed to the ETLF event. The second was to quantify the rate of change of settlement to ascertain if the reaction is accelerating or decelerating vertically and/or laterally - and if so in what direction(s).

Most landfills measure settlement in terms of depth settled per time (e.g., 3 feet per year), or as a percentage of depth per time (e.g., 1.5% per year). However, to accurately quantify how the reaction is changing, we evaluated the rate of change in terms of percentage rate of settlement over time. The percentage of settlement is more accurate when evaluating change on a portion of the Landfill that ranges from 0 feet to over 300 feet in depth. Further, evaluating percentage settlement in terms of "rate of change" allowed us to identify settlement trends over time, even when the multiple topographic maps covered varying time intervals.

It should be noted that settlement alone does not necessarily define the RA-Data area. In fact, there are many more criteria that the Reaction Committee continually evaluates in determining RA-Data.

These additional criteria are defined in the Reaction Committee's boundary determination submitted on September 9, 2025. These criteria include, without limitation, wellhead temperatures, down-well leachate liquid temperatures, liquid levels, LFG composition, and LFG surface emission monitoring (SEM) results.

METHODOLOGY

Settlement

Settlement occurs at all landfills to varying degrees and is the result of several interrelated factors, which we examine, in turn, below.

Initial Compaction Density

Landfills that achieve a high rate of compaction density during initial waste placement will generally see less incremental settlement after placement, though they may achieve a greater ultimate settlement. Operational practices at the CCL historically in-placed waste at a density that exceeded normal industry standard practice. Consequently, by achieving a higher rate of compaction density during initial waste placement, we would expect to see more gradual settlement per year, with an ultimate density above that achieved by the typical landfill.

Waste Type

Most of the settlement that occurs at landfills results from organic material breaking down through biological decomposition and physical deformation. Thus, it follows that landfills that receive a higher percentage of organic material will settle more and settle faster. However, even inert materials within a landfill will break down physically and as it does, smaller pieces of waste will tend to move downward to fill in the voids that may exist in between coarse, bulky material.

Physical Loading

The waste mass in every landfill is supported by the physical structure of the waste itself. Even paper and cardboard can provide small, almost microscopic trusses, while larger items like poles and lumber can create a complex system of beams, columns, and trusses the help support the waste mass.

Over time, those supporting structures in the landfill's waste mass are impacted by the loading (weight) of subsequent overlying layers of material (waste and soil). That loading, along with the processes of creep, deformation, and compression, will eventually cause the supporting structure of the waste mass to gradually lose strength and fail, thereby allowing the landfill to settle. Other factors like increasing moisture content and decomposition will exacerbate the loss of physical strength. For example, cellulose fibers that are present in wood, brush, cardboard and other materials will decompose and soften over time.

Biological Decomposition

All organics within the Landfill are at some state of decomposing. In the process, solid organic material is converted into gas. This process of biological decomposition is normal. However, in the case of the ETLF portion of the Landfill, biological decomposition is quite accelerated, resulting in rapid liberation of LFG, liquid leachate, and associated settlement.

Chemical Processes

Within all landfills, there are also chemical processes that will weaken the internal supporting structures leading to a loss of support and eventual settlement. Ferrous metal will rust (i.e., oxidize) over time and whatever support was initially provided by those items will be lost.

The amount of settlement, and time period over which it occurs is generally predictable at most landfills, but not at landfills that are experiencing ETLF conditions.

Also, the ultimate settlement at any landfill, including CCL, and the time required to settle is very dependent on the overall depth of waste. The greater the overall depth of waste, the greater the loading on lower layers, and thus the greater the degree of settlement. This can be exacerbated during ETLF conditions due to the higher temperatures and the increased liberation of liquid leachate.

Consequently, even though waste may have been placed at a constant density during the operational phases of the Landfill, the lower portions of the waste column will become denser as additional layers (i.e., loading) are placed. This is shown conceptually in Figure 6 where we can see the first layer (at time 0) is placed at a certain density, and it consumes a specific depth of landfill airspace. However, as subsequent layers are stacked on top, and even though each new layer is placed at the same density and consumes a similar depth of airspace, the underlying layers become progressively more compressed (e.g., denser). Consequently, the lower layers, which have the greatest loading, receive the greatest loading and therefore achieve the highest density.

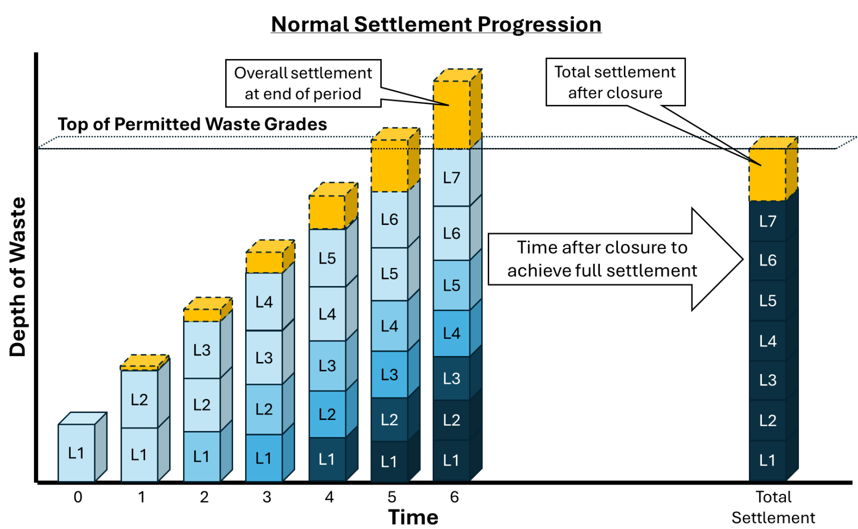


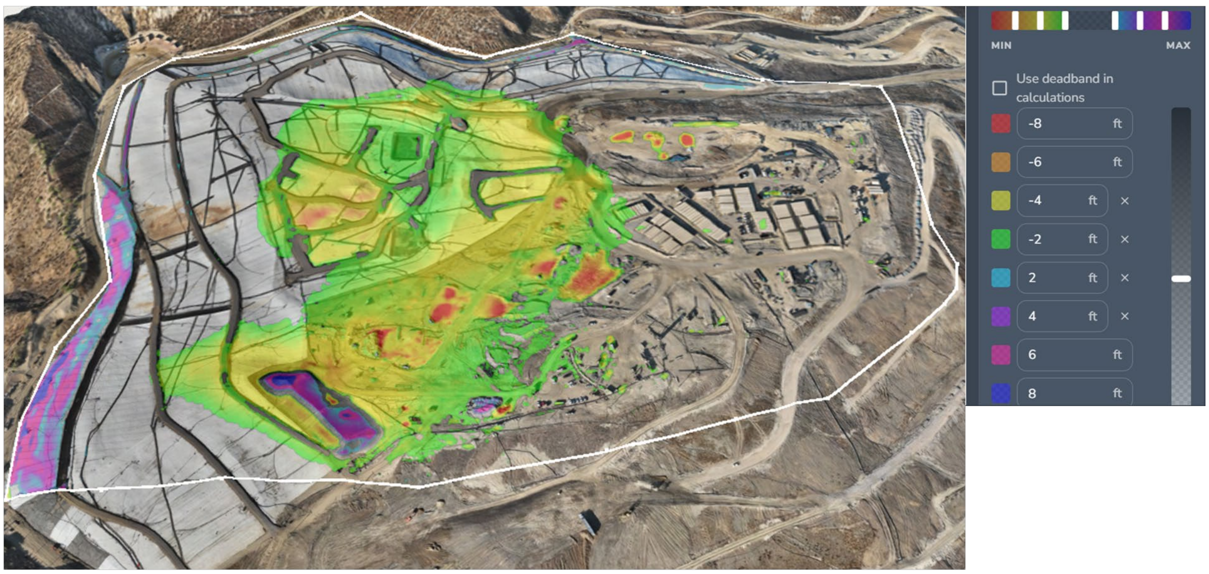
Figure 6

Settlement is typically quantified by either overall settlement depth measured in an elevation change or as a percentage of settlement. The percentage of settlement is calculated by dividing the measured depth of settlement by the depth of the underlying waste prior to settlement occurring. Both can be presented for a specific interval of time such as annually, or the total timeframe of the site such as lifetime ultimate settlement.

Both methods require a before and after topographic map of the Landfill.

CCL continues to create and submit a monthly isopach map to several regulatory agencies which show an isopach image of settlement across a specific portion of the Landfill. Those isopach maps use various colors to illustrate the degree of settlement in specific areas. This is measured in feet and provides a visual representation of where and how much the surface topography has settled as is shown in Figure 7.

Chiquita Canyon Landfill - Isopach



January 3, 2025 Survey Image. October 2, 2024 vs January 3, 2025

Figure 7

Baseline Settlement

Every landfill settles over time, but as previously noted, the rate of settlement varies from one landfill to another. To identify and quantify surface settlement caused directly and/or indirectly by the ETLF reaction, we had to establish a baseline settlement rate that applied specifically to CCL and which was outside the RA-Data.

It is important to note that unlike overall settlement measured in elevation change, the rate of change is influenced by the depth of waste in relation to a period of time. Because it is measured by the elevation change divided by the depth of waste prior to settlement occurring, the rate of change in shallow waste can be more than in deeper waste as Figure 8 shows. This is evident in the isopach maps in later sections of this report.

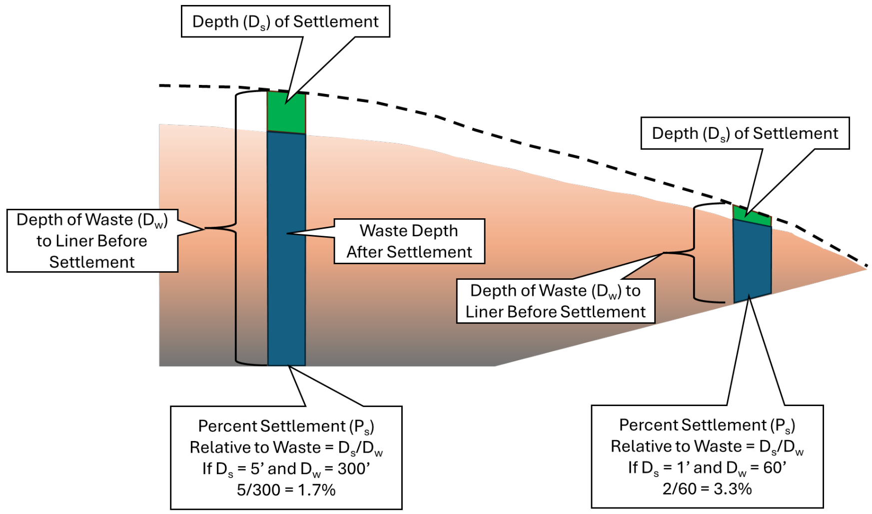


Figure 8

The portion of CCL we selected for our settlement baseline was in the southeast portion of the Landfill (See Figure 9). This area was chosen because it was furthest from the RA-Data and had not recently received any new waste (from 2021-2025).

The initial baseline analysis area (the blue boundary) had a grid of sample points every 50 feet, providing 850 points on a 50-foot grid pattern. From this area we extracted annual elevation points over a 4-year period.

However, under closer inspection and after pulling those points into CAD and Excel, we discovered that there were areas where some localized activity occurred within the four-year period. Consequently, we reduced the area from 850 points to 324 points where there was less significant change to the topography year-to-year. This area, with its 324 points (within the green boundary) was used as our non-reaction baseline for defining typical settlement.

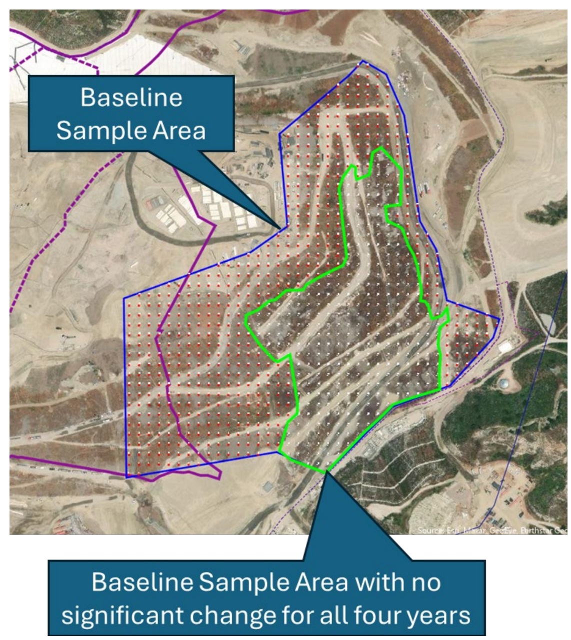


Figure 9

Surface elevations for each of those 4 years were recorded for each of those 324 points resulting in a total of 1,296 elevation data points.

Using the elevation data points, we measured the elevation change between each year's topographic mapping. Because some minor grading (i.e., cutting and filling) activities did occur within the final dataset, there were some outliers in terms of year-to-year settlement. To address those elevation anomalies, we eliminated the upper and lower 2% of the points. A total of 50 points were eliminated, leaving a remainder of 1,246 points for our baseline settlement calculation.

All elevations were then evaluated in a scatter plot showing the annual change in elevation relative to the depth of waste at the start of the year (See Figure 10). This data showed a clear pattern of settlement that was in line with industry standards. Please note that in our calculations, we began by calculating daily percentage settlement to account for topographic maps that ranged from weekly to monthly. Then, we standardized all settlement results by converting them to an annualized percentage settlement based on total waste depth.

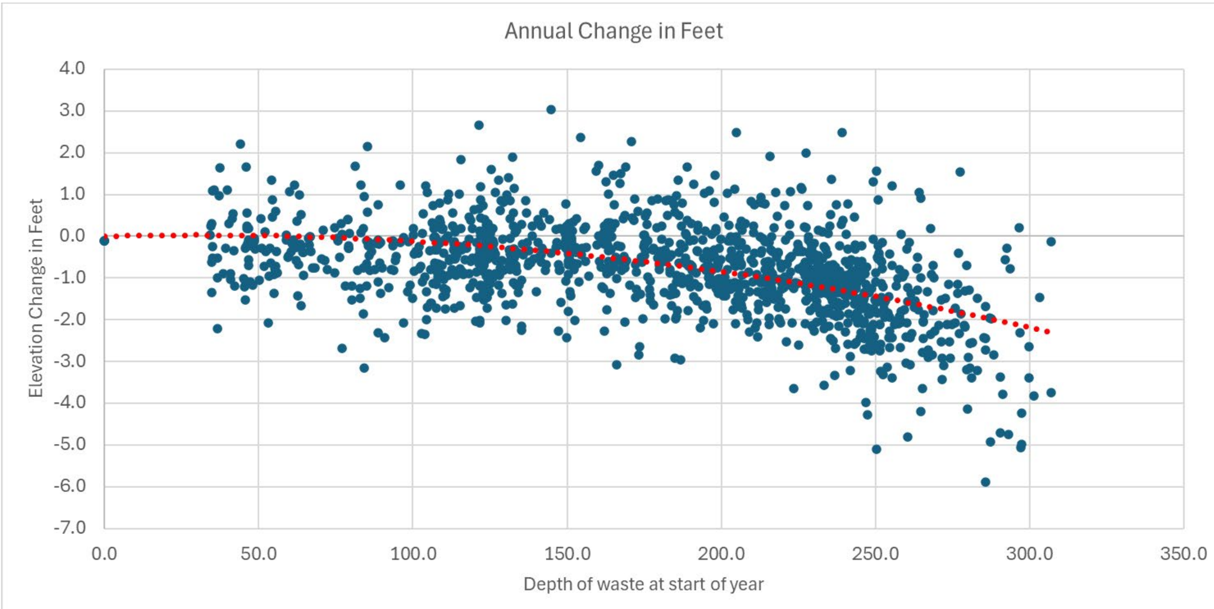


Figure 10

Please note that along with the settlement data which is shown as a negative value (in feet), there are certain areas that show positive values, which indicate localized fill activity or potentially some error in topographical mapping. During our review of the topographic maps over that four-year period, we determined that many of those areas that showed up as fill were in fact related to road maintenance, slope repair, and placement and removal of stockpiled material.

Finally, to help quantify the time component regarding settlement, we showed the average annual settlement percentage for the entire baseline area. The annualized rate of change (i.e., percentage settlement) appeared to be in line with industry standards at 0%-2.1% per year, as shown in Figure 11.

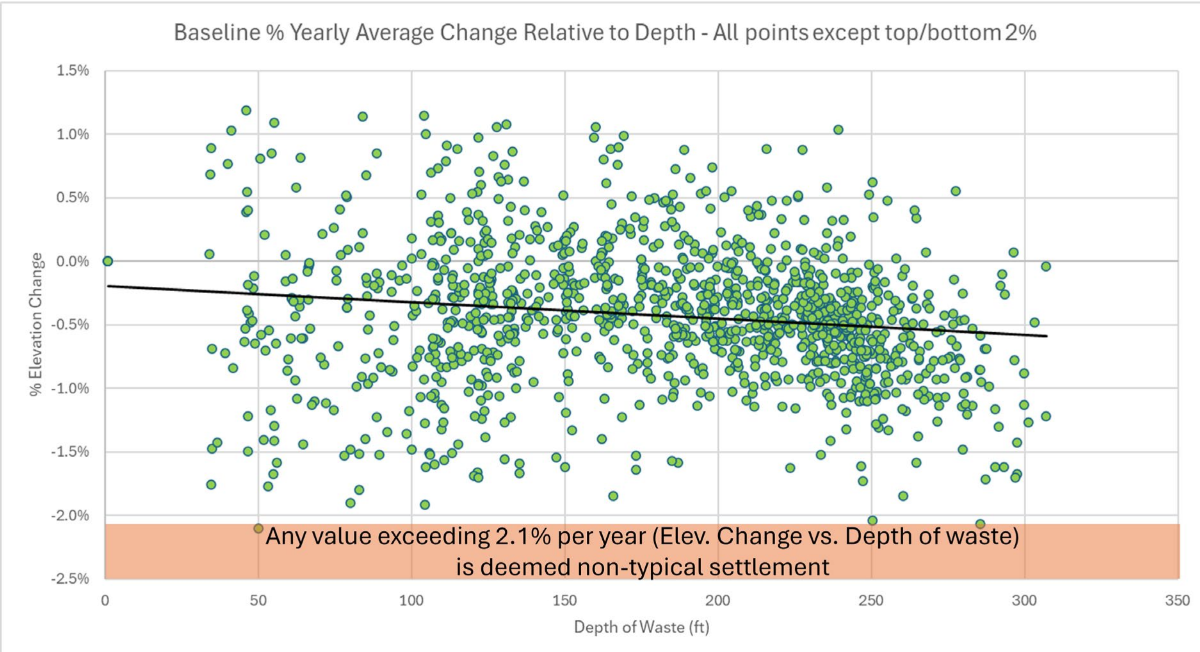


Figure 11

These baseline rates of change, which we deemed to be typical of CCL allowed us to conversely determine settlement rates that were outside the norm for CCL. We then used this data to identify annualized elevation changes in and around the RA-Data. In that regard, we determined that CCL's typical annualized settlement change was 2.1% of the waste depth, and that any settlement greater than 2.1% could be attributed directly or indirectly to the reaction. Again, please note that by convention, the landfill industry measures settlement on an annual basis. So, even though we had before and after topographic maps from intervals as frequent as weekly; by converting all data to an annualized settlement rate, we maintained the industry's standard units of measurement.

Detailed Site Settlement Analysis

With CCL's baseline settlement rate established, BRS generated new data sample points across the entire site. We selected data points based on the existing inspection grid, dividing each into quadrants, placing sample points at the center of each of those quadrants as is shown in Figure 12 with green background.

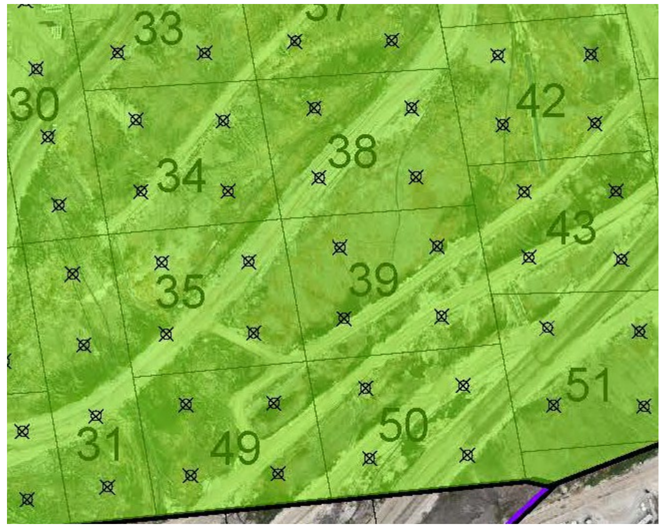


Figure 12

In this manner, a total of 718 points were generated across the entire Landfill footprint as shown here in Figure 13.

For the 2-year evaluation period, there were 82 individual topographic maps generated through Propeller. This equates to 81 *before and after* sample periods where elevation change occurred and 81 periods were evaluated. By taking an elevation for each of the 718 sample points from each of the surfaces, a total of 58,138 elevation change data points were obtained.

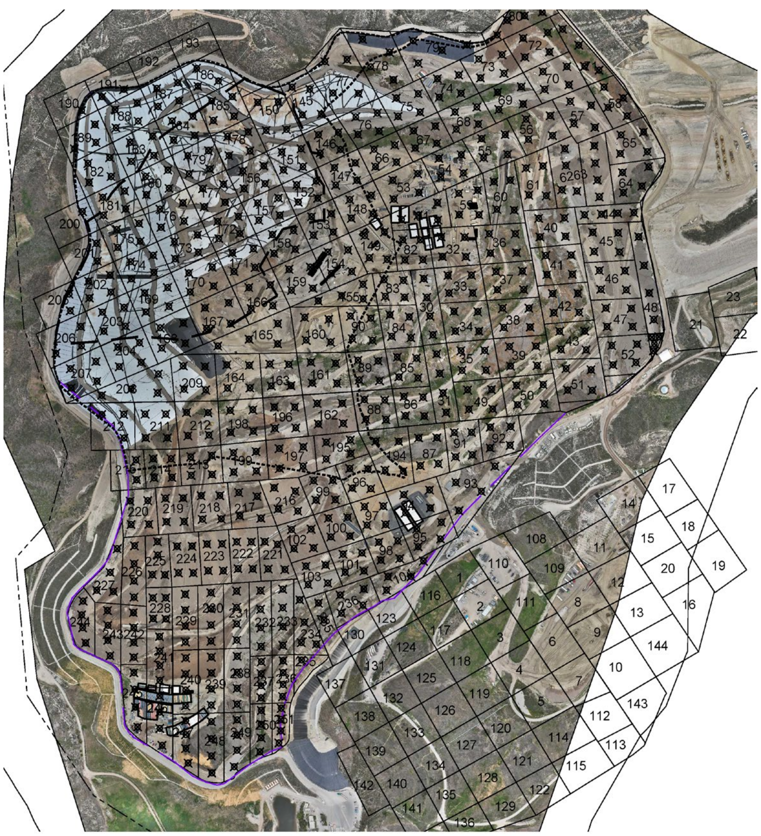


Figure 13

The isopach shown here (See Figure 14) shows the positive and negative (fill or cut) elevation changes for all 58,138 data points for the two-year analysis period. Based on this before and after comparison, the RA-Data and its influence (e.g., depth of settlement) on adjacent areas can be clearly seen.

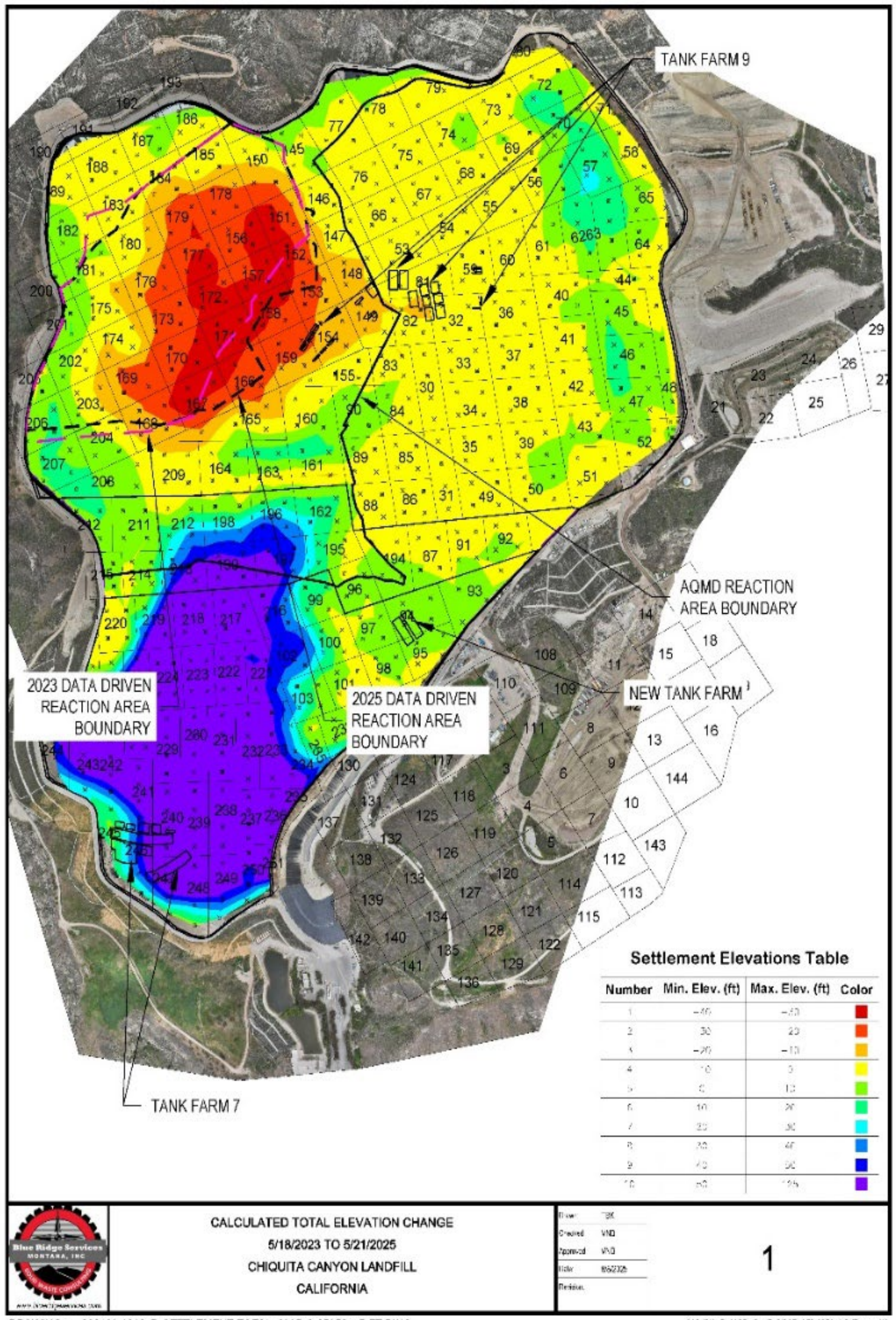


Figure 14

Total Settlement: North Half

However, because waste filling was still occurring in the southern portion of the Landfill during the analysis period (May 18, 2023, through May 21, 2025) we reduced our data set from 718 points, down to only 453 points in the north half of the Landfill. These were used with the sample area shown in Figure 15 as the green area. This resulted in a total of 37,146 points remaining for analysis.

Using data points from the north half, the first analysis was for total settlement between the start and end of the evaluation period, that being May 18, 2023, through May 21, 2025. This was done with more detailed gradation in the settlement depth color bands to identify the area of the reaction that showed the most subsidence. The purpose was to identify the potential horizontal limit of the reaction itself. Additionally, it shows the adjacent areas that were directly or indirectly impacted by the excessive settlement in the area experiencing the ETLF event.

Rate of Change

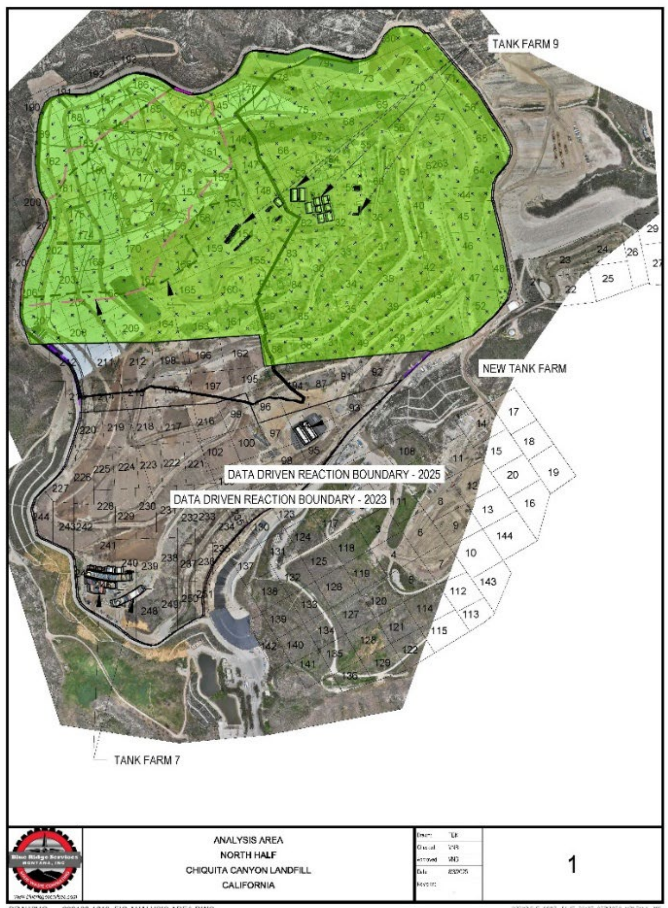


Figure 15

The rate of change is simply taking the percentage of elevation change relative to depth in relation to a time interval. Typically, settlement evaluations of a site are done on a yearly basis with CCL submitting monthly submissions showing the settlement for the month, expressed in feet.

In the analysis for this report, it was necessary to convert the data into a change in elevation per day because the Propeller drone mapping flights varied in frequency. Initially the mapping flights were performed monthly and then increased to twice a month. Now, these mapping flights occur weekly.

To adjust for this inconsistency in between mapping periods, we calculated the number of days in that period and then divided by the total elevation change for each point. At each point with the known elevation change per day for that period, it was then divided by the depth of waste at the start of the period in question. This elevation resulted in a percentage change in elevation per day relative to the depth of waste.

As previously noted, we converted the rate of change from daily to an annualized percent rate of change to comply with the industry's standard practice of expressing landfill settlement per year. Figure 16 shows the average annual percentage settlement per year over the two-year period of the evaluation. The two-year total average clearly shows the limits of the reaction with the yearly average providing more detail on the impact of the reaction to the east. Most of the area outside of the RA-Data is experiencing a rate of change of less than 2% per year (purple and dark blue zones), which is within the baseline.

Any additional increase is likely the indirect result of the reaction through horizontal migration of heat and liquids as well as liquid removal as part of the mitigation efforts.

To help visualize any potential that the reaction was spreading, we also evaluated the rates of change on a reduced frequency.

By evaluating the percentage settlement monthly, the dynamic nature of CCL became more evident. This is particularly evident along the northeastern and eastern perimeter of the landfill (See Figure 16).

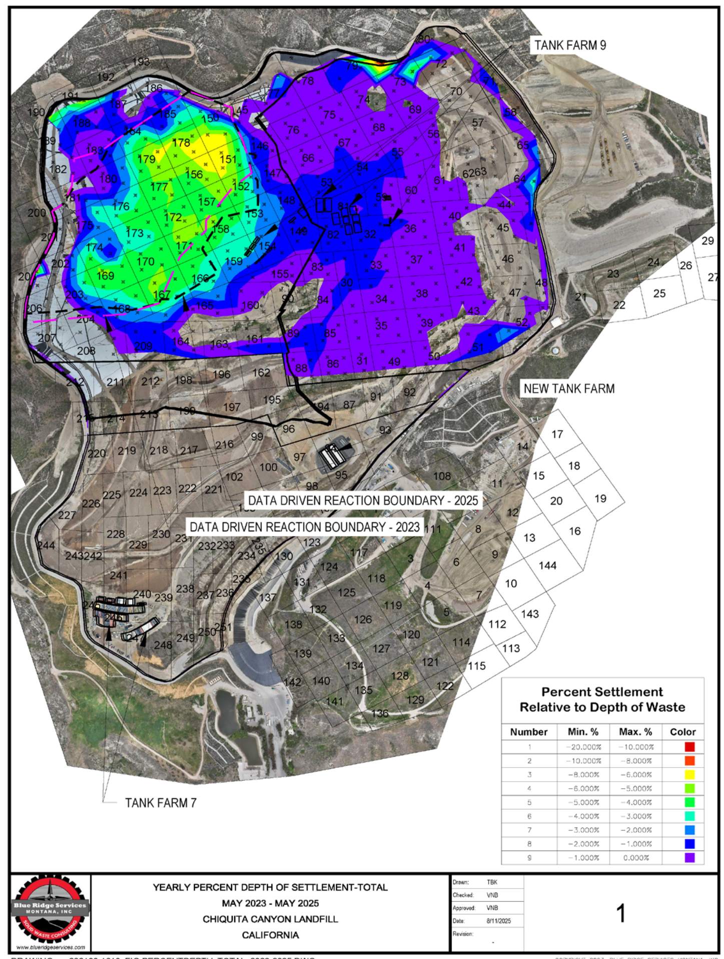


Figure 16

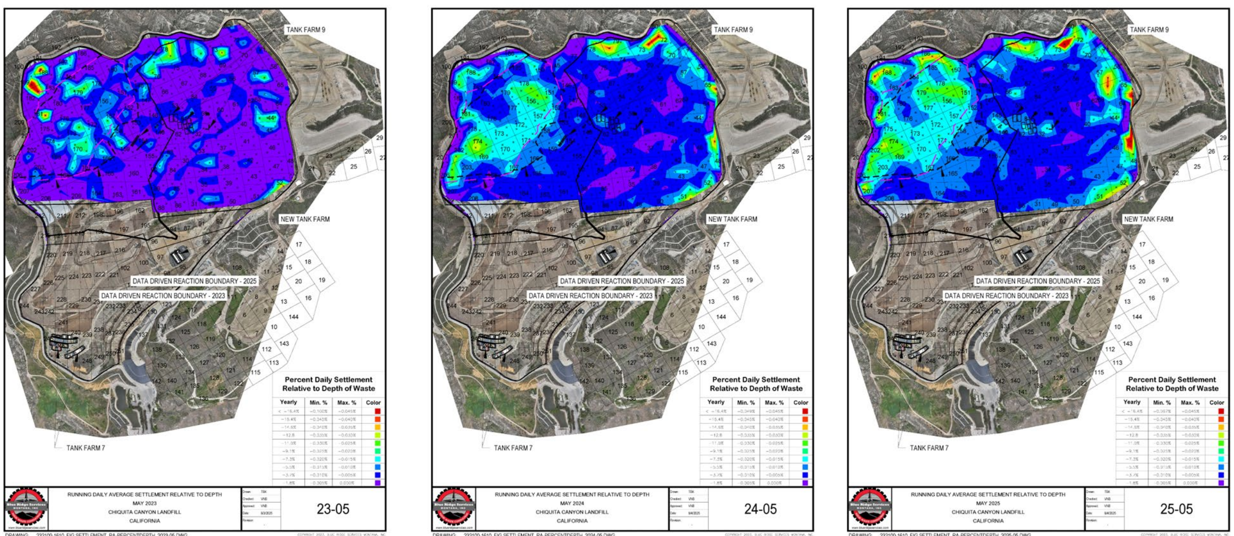
Based on review of aerial photo imagery at the time topography was generated and on review of the surfaces of selected topography the variations in the percentage settlements were due to localized grading, the adding and removing of stockpiles, placing or removing tanks, repairing settled areas, and other activities.

The effect of minor modifications to the surface elevation are much more evident along the perimeter where waste is shallow. Remember that the percentage change in settlement is based on the elevation change divided by the underlying depth of waste. Where the waste depth is shallow, the denominator becomes very small, so even minor changes in the numerator result in exaggerated percentage settlement.

Another likely contributor to these fluctuations is the massive quantities of liquids that have been, and continue to be, removed from the site through wells and the LCS. This loss of volume is likely causing some subsurface consolidation. To address these fluctuations, a Cumulative Average and a 3-Month Rolling Average were used to buffer out the extremes in the data.

Cumulative Average

The Cumulative Average is the running average of all data sets measured from the starting date to each monthly increment. As an example, the following Figure 17 shows the cumulative daily average, averaged from the start of the two-year period, for May 2023, May 2024, and May 2025. The full set of monthly comparisons can be found in Appendix A.



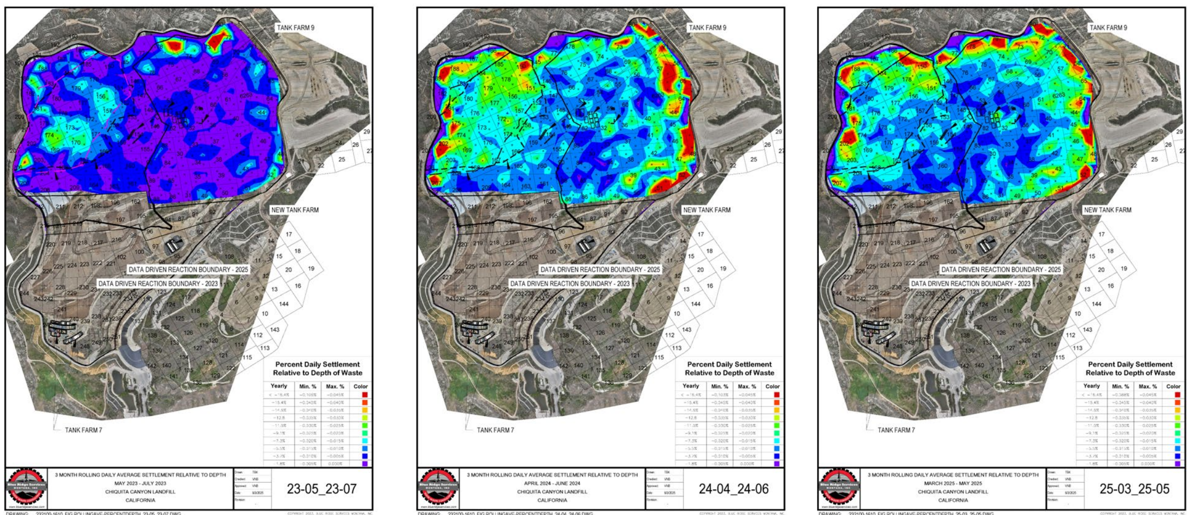
Start: May 2023 **Middle: May 2024** **End: May 2025**

Cumulative Running Average

Figure 17

3-Month Rolling Average

Our last analysis was to create a 3-month rolling average of the daily percent change in elevation relative to the depth of waste. However, rather than average the rate of change from the earliest topographic map, in this analysis we simply averaged the settlement that was happening over a 3-month period, with those 3 months rolling every month. As an example, the following Figure 18 shows the rolling average for the periods of May through July 2023, April through June 2024, and March through May 2025. The full series can be found in Appendix B.



Start: May-July 2023 **Middle: April-June 2024** **End: March-May 2025**

3-Month Rolling Average

Figure 18

Based on the cumulative and 3-month rolling averages, though there are areas of increased settlement outside of the RA-Data boundary, the majority are below the rates seen within the RA-Data. When high rates of settlement are observed, they are not consistent enough to indicate that the reaction has spread to the east – or beyond the current RA-Data boundary.

CONCLUSION

Our analysis shows that the rate of change of settlement within the RA-Data is slowing. Similarly, the rate of change of settlement in areas outside – but adjacent to – the RA-Data is also slowing.

We believe those changes inside and outside the RA-Data are interrelated and are more likely the result of the indirect effects of the main subsurface reaction inside the RA-Data. The variability in rate of change of settlement in areas outside the RA-Data are the result of horizontal migration of liquids and heat causing the normal decomposition rate to increase, but not at a rate that could be associated with an ETLF event.