# *DRAFT*

# Screening-Level Ecological Risk Assessment

## CHEVRON DIESEL FUEL SPILL

Willard Bay State Park, Box Elder County, Utah

**Prepared for:**

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## EXECUTIVE SUMMARY

This report provides a Screening-Level Ecological Risk Assessment (SLERA), which evaluates the potential for ecological risk to community-level receptors exposed to residual diesel contamination in aquatic and wetland habitats at the Willard Bay State Park, Utah. The SLERA is based on U.S. EPA guidance for conducting ERAs at Superfund sites. It was also prepared on the basis of an ERA work plan approved by the Utah Department of Environmental Quality.

Willard Bay is a 9,900-acre (40 $km^2$) freshwater reservoir located in eastern Box Elder County, Utah, 12 miles northwest of the city of Ogden, on the north-eastern floodplains of the Great Salt Lake. Willard Bay State Park (the Site) is located on the eastern shore of Willard Bay. A diesel fuel leak from an 8-inch petroleum pipeline near the Site was detected on March 18, 2013. An investigation showed that the pipeline running between Interstate 15 and Willard Bay experienced a 74-inch longitudinal seam failure.

The spill occurred mostly within Willard Bay State Park on land owned by the Bureau of Reclamation (U.S. Department of Interior) and managed by the State of Utah. A channel and around seven acres of wetlands were impacted by over 25,000 gallons of diesel fuel. The Utah Department of Environmental Quality (UDEQ), Division of Water Quality (DWQ), issued a Notice of Violation and Compliance Order (NOV/CO) on April 11, 2013. The NOV/CO indicated that sheens were present in the wetland areas. Preliminary analytical data also showed that shallow groundwater, surface soils, and subsurface soils had been impacted with diesel fuel in areas within Willard Bay State Park.

A nearly straight channel, known as the Channel Segments, runs from east (location of the spill) to west (the wetlands). It carries surface water which originates on the east side of Interstate-15 (I-15) and is primarily derived from shallow groundwater discharge and land drainage from unimproved pastures. The banks of the channel are steep-sided, 3-5 meters (m) apart and roughly 2 m above the bed. The channel also runs about 40 m east of the Park Access Road to southbound I-15. The channel west of the Park Access Road is broken up by several culverts between intersecting roads and park access trails. The channel runs for about 200 m west from the Park Access Road before opening up into several beaver-pond wetlands.

The Site was extensively sampled between March 2013 and November 2013, both before and after the cleanup efforts, for analysis of Diesel Range Organics (DROs), plus Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs) (including Polycyclic Aromatic Hydrocarbons [PAHs]) typically associated with diesel fuels. All the surface water and sediment analytical data used in the SLERA represented post-remedial residual levels of diesel fuel components.

Metals were excluded from the evaluation. Chevron submitted one pipeline diesel sample collected after the accidental release on March 18, 2013 and also analyzed a diesel sample collected at the Site itself on March 19, 2013. Both samples were analyzed for 25 metals and metalloids. The concentrations of all the inorganic compounds measured in these two

samples fell below their reported detection limits. As a result, a consensus was reached among all the stakeholders that metals would not be included in the SLERA.

Three channel segments and four wetland areas were identified as target habitats for evaluation in the SLERA, based on habitat characteristics and the potential for direct exposure by community-level aquatic receptors. However, the relatively small sizes of some of the datasets, and the presence of numerous non-detect values, made it necessary to combine these habitats into larger EUs in order to form more robust datasets to help derive Exposure Point Concentrations (EPCs). These EPCs represent concentrations to which the receptors of concern are assumed to be exposed.

The community-level receptors of concern consist of aquatic invertebrates (both benthic invertebrates and water column invertebrates), fish, and larval stages of amphibians. Birds and mammals were not assessed in this SLERA because remedial actions targeted the removal of all free diesel fuel from the Site. In addition, residual compounds are not expected to bioaccumulate, bioconcentrate or biomagnify within food chains because they are extensively metabolized by community-level receptors lower in the food chain.

The maximum concentrations of analytes detected in surface water and sediment samples collected at the Site were compared to published chronic surface water benchmarks (SWBs) and to sediment Equilibrium Partitioning-based Ecological Screening Benchmarks (ESBs) to identify Contaminants of Potential Ecological Concern (COPECs). Analytes with maximum detected concentrations above their screening benchmarks, as well as detected analytes which lacked screening benchmarks or non-detected analytes with ½ their maximum Method Detection Limits (MDLs) above their screening benchmarks, were retained as COPECs for further evaluation in the SLERA.

Chevron also performed an independent study to estimate the potential toxicity of sediment pore water to benthic invertebrates. Chevron obtained split samples of sediment collected in the wetland ponds and the channel segments in August and November 2013 and submitted them for processing and analysis. The pore water samples were obtained by centrifugation, supernatant collection, and flocculation. Solid Phase Microextraction (SPME) was then used to remove the PAHs in each pore water sample. The SPME fibers were desorbed in a gas chromatogram/gas spectrometer for analysis of 34 dissolved PAHs consisting of 18 parent PAHs and 16 groups of alkylated daughter PAHs.

The PAH analytical results obtained from each pore water sample were converted to Toxic Units (TU = measured concentration/Final Chronic Value). The PAH-specific TUs in each sample were then summed across the 34 PAHs (detected values only) to calculate a sample-specific $\Sigma$TU $PAH_{34}$. To help in the data evaluation, it was decided to interpret a $\Sigma$TU $PAH_{34}$ of 1.0 or less as falling below a "no effect" toxicity threshold and a $\Sigma$TU $PAH_{34}$ of 5.0 or above as exceeding an "effect" threshold. $\Sigma$TU $PAH_{34}$ values between 1.0 and 5.0 remained open to future risk management discussions. The results of the pore water analyses were not used as a separate measurement endpoint in the SLERA, but instead provided a line of evidence in the risk characterization.

The table below summarizes the surface water and sediment COPECs retained after the initial screening.

| Surface Water (µg/L) | | | | |
|---|---|---|---|---|
| **Analyte** | **Frequency of detection** | **Max. conc. (or ½ max. MDL for non detects)** | **Benchmark** | **Requires further evaluation?** |
| 4-isopropyltoluene | 0/15 | 0.1895 | NA | No |
| 7, 12-dimethylbenz(a)anthracene | 0/15 | 0.535 | NA | No |
| n-octadecane | 0/15 | 0.401 | 0.013 | No, but uncertain |
| DRO | 0/15 | 68 | NA | No |
| **Sediment (µg/kg)** | | | | |
| ***Wetland Ponds 1, 2, & 3*** | | | | |
| 4-isopropyltoluene | 4/13 | 4.57 | NA | No |
| DRO | 16/16 | 438,000 | NA | Yes |
| ***Wetland Pond 1A*** | | | | |
| 4-isopropyltoluene | 0/3 | 0.16 | NA | No |
| DRO | 4/4 | 52,300 | NA | No |
| ***Channel Segments*** | | | | |
| 4-isopropyltoluene | 7/13 | 36.1 | NA | No |
| DRO | 15/15 | 2,820,000 | NA | Yes |

NA = not available; MDL = method detection limit

## Surface water:

Four analytes were present above their MDL in surface water, but in only one or two of the 15 samples collected at the Site. None of the four were retained as COPECs for further refinement because all had maximum detected concentrations that fell below their SWB. However, four non-detected diesel-related compounds in surface water either lacked SWBs (i.e., 4-isopropyltoluene, 7,12-dimethylbenz(a)anthracene, and Diesel-Range Organics [DRO]) or one half of the maximum MDL exceeded the SWB (n-octadecane).

It was concluded that these four non-detected analytes were unlikely to represent actionable risk to aquatic community-level receptors based on their absence from surface water samples. This conclusion had high uncertainty for n-octadecane because ½ its maximum MDL of 0.401 µg/L exceeded its SWB of 0.013 µg/L by over two orders of magnitude.

## Bulk Sediment:

Only 4-isopropyltoluene and DRO were consistently retained as COPECs in sediment samples from the three sediment Exposure Units (EU, i.e., Wetland Ponds 1, 2 and 3, Wetland Pond 1A, and the Channel Segments) due to a lack of benchmarks for these two compounds. All other analytes were removed as COPECs because either the maximum detected concentrations or one half the maximum MDL for non-detected analytes did not exceed the ESBs.

ProUCL software was used to calculate two DRO Upper Tolerance Limits (UTLs) using the analytical data from the background pond and background creek sediment samples. These two values, which equaled 232,000 µg/kg and 141,000 µg/kg, respectively, also represented the maximum detected sediment DRO levels measured at both background locations. Note that, in

the absence of a DRO sediment screening benchmark, exceeding the UTL did not mean the presence of ecological risk, but only suggested that those DRO levels were likely a spill-related signal.

- Wetland Ponds 1, 2 and 3:

  4-Isopropyltoluene was detected in four out of 13 sediment samples collected from this EU. This aromatic compound consists of 10 carbons, which places it in the same category as the $C_9$ to $C_{12}$ aromatic hydrocarbon fraction for which the Massachusetts Department of Environmental Protection developed a generic sediment ESB of 230 µg/kg (@ 1% Total Organic Carbon [TOC]). This information showed that the maximum detected concentration of 4-isopropyltoluene (4.57 ug/kg with 0.526% TOC) in sediment samples collected from this EU most likely did not represent unacceptable risk to the local benthic invertebrate community. Therefore, this analyte was removed from further consideration.

  DRO was detected in all 16 sediment samples, with a maximum detected concentration of 438,000 ug/kg at sample location WP2-SS-12. A duplicate sample (WP2-SS-15) collected at this location showed 198,000 ug/kg DRO. Except for the 438,000 µg/kg DRO at WP2-SS-12, all other DRO levels in the sediment samples from Wetland Ponds 1, 2, and 3 fell below the UTL. This pattern suggested that, with one exception, the presence of DRO in sediment collected from Wetland Ponds 1, 2, and 3 mostly reflected background conditions.

- Wetland Pond 1A:

  4-Isopropyltoluene was not detected in any of the sediment samples collected from this EU. One half the maximum MDL equaled 0.16 µg/kg (@ 0.73% TOC), which fell well below the generic ESB of 230 µg/kg (@ 1% TOC). Therefore, this analyte was removed from further consideration.

  DRO was detected in all the sediment samples collected from this EU. The maximum DRO concentration (52,300 ug/kg) was much lower than the background UTL of 232,000 ug/kg. This information suggested that the DRO levels measured in the Wetland Pond 1A sediment reflected background conditions.

- Channel Segments 1, 2 and 3:

  4-isopropyltoluene was detected in seven of the 13 sediment samples collected from this EU at a maximum detected concentration of 36.1 µg/kg (@ 1.63% TOC), which fell well below the generic ESB of 230 µg/kg (@ 1% TOC). Therefore, this analyte was removed from further consideration.

  DRO was detected in all 15 of the Channel Segment sediment samples. The background creek sediment UTL for DRO was 141,000 µg/kg.

- *Channel Segment 1*: The highest sediment DRO level equaled 83,800 µg/kg, which fell below the background creek UTL. The DRO levels within this channel segment represented background. This analyte was removed from further consideration.

- *Channel Segment 2*: The highest sediment DRO level (2,820,000 µg/kg) was measured at CS2-SS-B-03. This value exceeded the background creek DRO UTL of 141,000 µg/kg by 20 times. The ΣTU $PAH_{34}$ for this sample equaled 20.4 which predicted toxicity to benthic invertebrates. However, sample locations CS2-SS-B01 and CS2-SS-B02, found next to CS2-SS-B03, had DRO levels of 42,100 µg/kg and 56,300 ug/kg, respectively, which represented background. This pattern likely indicated a localized DRO "hot spot." A second DRO UTL exceedance was observed at CS2-SS-A-02 (243,000 µg/kg). The ΣTU $PAH_{34}$ for this sample equaled 16, which also predicted toxicity to benthic invertebrates. DRO in Channel Segment 2 could not be eliminated as a COPEC and may require further evaluation as part of the risk management decision process.

- *Channel Segment 3*: The sediment DRO levels at four of the six sampling locations in Segment Channel 3 exceeded the background creek UTL of 141,000 µg/kg. These exceedances ranged from 143,000 µg/kg to 900,000 µg/kg. Pore water was collected from four of the six sediment sampling locations in this channel segment to measure ΣTU $PAH_{34}$. The pore water from the three sediment samples with DRO levels above the background Creek UTL was predicted to be non-toxic, whereas the fourth sediment sample (CS3-SS-A-01), with a DRO level of 138,000 µg/kg, was predicted to have highly-toxic pore water (ΣTU $PAH_{34}$ = 34). DRO in Channel Segment 3 could not be eliminated as a COPEC and may require further evaluation as part of the risk management decision process.

It is concluded, based on the outcome of this SLERA, that the potential risk to the aquatic community receptors exposed to surface water at Willard Bay State Park is negligible.

It is also concluded that DRO in sediment remains as a major uncertainty due to a lack of a screening benchmark to determine effect. The presence of DRO above background levels in sediment at several sampling locations and with several ΣTU $PAH_{34}$ measures in excess of 5.0 suggests the potential for unquantified ecological risk to the benthic invertebrate community at select locations. This outcome may indicate the need for additional scrutiny.

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## LIST OF ACRONYMS

| | |
|---|---|
| AWAL | American West Analytical Laboratory |
| BERA | baseline ecological risk assessment |
| CTE | central tendency exposure |
| COPEC | contaminant of potential ecological concern |
| CS | channel segment |
| DRO | diesel range organic |
| DWQ | Division of Water Quality |
| EPA | Environmental Protection Agency |
| EPC | exposure point concentration |
| ERAGS | Ecological Risk Assessment Guidance for Superfund |
| ESB | ecological screening benchmark |
| ESL | ecological screening level |
| Eq-P | equilibrium partitioning |
| ESB | equilibrium partitioning sediment benchmark |
| EU | exposure unit |
| FCV | Final Chronic Value |
| HHRA | human health risk assessment |
| HQ | hazard quotient |
| LCV | lowest chronic value |
| MDL | method detection limit |
| mg/kg | milligrams per kilogram (parts per million) |
| mg/L | milligrams per liter (parts per million) |
| ND | non-detect |
| NFG | National Functional Guidelines |
| NOV/CO | Notice of Violation and Compliance Order |
| OC | organic carbon |
| PAH | polycyclic aromatic hydrocarbons |
| ppm | parts per million |
| RME | reasonable maximum exposure |
| ROC | receptors of concern |
| SCM | site conceptual model |
| SCV | secondary chronic value |
| SLERA | screening-level ecological risk assessment |
| SMDP | scientific management decision point |
| SPME | solid phase micro-extraction |
| SQC | sediment quality criteria |
| SQuiRT | screening quick reference table |
| SVOCs | semi-volatile organic compounds |
| SWB | surface water benchmark |
| TPH-DRO | total petroleum hydrocarbons-diesel range organics |
| TOC | total organic carbon |
| µg/kg | micrograms per kilogram (parts per billion) |
| µg/L | micrograms per liter (parts per billion) |
| USFWS | United States Fish and Wildlife Service |

| | |
|---|---|
| USGS | United States Geological Survey |
| Utah GMS | Utah Geological and Mineral Survey |
| UTL | Upper tolerance limit |
| UDEQ | Utah Department of Environmental Quality |
| VOCs | volatile organic compounds |

# 1.0 GENERAL INTRODUCTION

## 1.1 Scope

On behalf of the Utah Department of Environmental Quality (UDEQ) Division of Water Quality (DWQ), the oversight agency of the Willard Bay Diesel Spill, TechLaw, Inc. (TechLaw) prepared this Screening Level Ecological Risk Assessment (SLERA) to assess the potential risk associated with residual diesel fuel at Willard Bay State Park in Box Elder County, Utah. This report evaluates the potential for ecological risk to aquatic community-level receptors exposed to residual diesel fuel contamination in aquatic and wetland habitats. The SLERA was developed based on the Utah-approved Ecological Risk Assessment Work Plan (ERA WP) prepared for this site (TechLaw, 2013a).

The outcome of this process consisted of identifying a preliminary list of Chemicals of Potential Ecological Concern (COPECs) in surface water and sediment, which were then further discussed and refined to identify potential risk drivers that might require further evaluation as part of the risk management process.

## 1.2 General Screening Ecological Risk Assessment Approach

The following guidance and reference documents were used to prepare the SLERA:

- Utah Administrative Code, Rule R315-101-5, *Health Evaluation Criteria, Risk Assessment*, available at http://www.rules.utah.gov/publicat/code/r315/r315-101.htm (Note: this state rule is intended for use at hazardous waste sites, but its core principles applied to the SLERA).

- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*. EPA 540/R-97/006 (EPA, 1997).

- *Guidelines for Ecological Risk Assessment*. EPA 630/R-95/002F (EPA, 1998).

- ECO Update. 2001. The role of screening-level risk assessments and refining contaminants of concern in baseline ecological risk assessments. EPA 540/F-01/014 (EPA, 2001).

Environmental Protection Agency (EPA) (1997) provided the general framework for planning and conducting a SLERA. The screening process (Tier 1) consisted of two broad steps, namely problem formulation/ecological effects evaluation and exposure estimates/risk calculations. The major goal of a Tier 1 assessment was to identify the COPECs that needed further evaluation. These steps are described below in further detail.

- *STEP 1: Screening-level problem formulation and ecological effects evaluation*

The screening-level problem formulation included stressor characterization, identifying ecological receptors of concern, selecting assessment endpoints and measures of effect, and developing a Site Conceptual Model (SCM).

The Screening-level ecological effects evaluation quantified the toxicity of Site-related analytes based on published screening benchmarks or on benchmarks developed specifically for this evaluation using EPA-approved methods.

- *STEP 2: Screening-level exposure estimate and risk calculations*

The screening-level exposure estimate identified the Exposure Point Concentrations (EPCs) used in the evaluation. Contaminant-specific maximum detected concentrations were used as the EPCs to select the preliminary COPECs in the affected aquatic habitats at the Willard Bay spill site. The ERA WP (TechLaw 2013a) also envisioned a further refinement based on calculating Reasonable Maximum Exposures (RMEs) and Central Tendency Exposures (CTEs). This refinement was not implemented because all the preliminary COPECs represented analytes which lacked the benchmarks needed to calculate refined Hazard Quotients (HQs).

COPECs were selected by dividing the EPCs by their respective screening benchmarks. An analyte was retained as a preliminary COPEC for further evaluation under three conditions: (1) the HQ of a detected compound exceeded 1.0, (2) no screening benchmark was available to calculate an HQ for a compound present above its MDL, or (3) ½ the maximum MDL of a non-detected compound exceeded its screening benchmark. Note that the latter two conditions could not be evaluated quantitatively in the SLERA but are discussed in the uncertainty analysis of the risk characterization.

## 1.3 Goals and Objectives

Aquatic receptors (namely, benthic invertebrates, water column invertebrates, fish, and larval amphibians) present in the water bodies at or downstream from the ruptured pipeline area represented the valued ecological resources to be protected. Identifying these receptor groups provided the basis to develop SLERA goals and objectives, and select assessment endpoints for use in the evaluation.

Birds and mammals are not evaluated in this SLERA. The reason is that all free diesel fuel was removed from the Site, the Site was remediated, and the residual diesel fuel components are not expected to bioaccumulate, bioconcentrate or biomagnify within the food chain because they are extensively metabolized by community-level receptors lower in the food chain. Screening-level food chain modeling was not performed because the SLERA assumed that direct exposure by community-level aquatic receptors to residual diesel fuel-derived organic compounds was substantially greater than in higher-trophic level receptors.

The ecological risk management goal for the Site was defined as follows:

"*Promote healthy and self-sustaining communities of aquatic community-level receptors in the channel segments and the wetland areas affected by the diesel fuel release"*.

Four ecological risk assessment objectives were identified to accomplish this goal:

- Identify the presence of Site-related COPECs that may pose a threat to aquatic community-level receptors;
- Document the nature and extent of the potential exposure and effects to those receptors;
- Develop risk estimates and identify uncertainties; and
- Identify the need for a risk management decision to prevent ecological impacts and accomplish the ecological risk management goal.

The purpose of the SLERA was to provide enough information for the risk managers to determine the potential for ecological risk and to have adequate information to use in risk management decision making.

# 2.0 SCREENING-LEVEL PROBLEM FORMULATION

## 2.1. Introduction

Steps 1 and 2 of the SLERA identify the potential Site-related threats to the environment and determine if further assessment is warranted.

## 2.2 Environmental Setting

### 2.2.1 General Site Description

Willard Bay is a 9,900-acre (40 $km^2$) freshwater reservoir located in eastern Box Elder County, Utah, 12 miles northwest of the city of Ogden, on the northeastern floodplains of the Great Salt Lake. Willard Bay State Park (the Site) is located on the eastern shore of Willard Bay (see Figure 1). A diesel fuel leak from an 8-inch petroleum pipeline located near the Site was detected on March 18, 2013. An investigation showed that the pipeline running between Interstate 15 (I-15) and Willard Bay experienced a 74-inch longitudinal seam failure.

It is estimated that about 25,000 gallons of diesel fuel were released to Willard Bay State Park on land owned by the Bureau of Reclamation (U.S. Department of Interior) and managed by the State of Utah. A drainage channel and about seven acres of wetlands were impacted by this material (see Figure 2). The UDEQ DWQ issued a Notice of Violation and Compliance Order (NOV/CO) on April 11, 2013. The NOV/CO indicated that sheens were present in the wetland areas. Preliminary analytical data also showed that shallow groundwater, surface soils, and subsurface soils had been impacted in areas within Willard Bay State Park.

Immediately following the spill in March 2013, cleanup crews placed absorbent booms at the site to contain the diesel and began pumping the contaminated water into tanker trucks. The impacted area was fenced off to eliminate potential human exposure to impacted areas. Remediation activities continued through June 2013. Environmental samples were collected concurrent with the cleanup to monitor the effectiveness of the response actions. Diesel-related hydrocarbons were detected in samples near the shoreline of the reservoir. In samples collected further from shore, hydrocarbons were mostly non-detect. Concentrations in the reservoir were mostly non-detect after interceptor trenches were constructed in early April (UDEQ 2013b). Additionally, DWQ collected fish tissue samples for analysis of diesel-related contaminants. No diesel-related contaminants were detected in the fish tissue samples (UDEQ 2013b).

### 2.2.2 Key Physical Site Characteristics

**Climate**

The Site lies at an elevation of 4,200 feet northeast of the Great Salt Lake. This area is considered arid to semi-arid, receiving less than 12 inches of rain per year. Summers are typically warm with occasional periods of hot weather while winters are generally short and cold. The historical maximum and minimum temperatures recorded at the nearest weather station are 105 °F (40.5 °C) and -26 °F (-3.3°C), respectively. The mean annual temperature for the area is about 50 °F (10 °C). Precipitation is highly variable. The wettest month on record at

the Migratory Bird Refuge located just north of the park was July 1949 with 4.07 in (10.4 cm) (UT GSM 1980).

**Geology**

According to a 1980 Utah Geological and Mineral Survey (Utah GMS) Report of Investigation, the Site is located near the eastern margin of the Basin and Range Physiographic Province. This eastern margin is characterized by north trending fault-block mountain ranges and intervening structural valleys. The Wasatch Mountains steep front delineates the boundary between the Basin and Range Physiographic Province and the Middle Rocky Mountain Physiographic Province. The Site lies in a valley, which is an arm of a broader basin that was formerly occupied by ancient Lake Bonneville, of which Great Salt Lake is a remnant (Utah Geological and Mineral Survey, (UT GSM, 1980).

A Utah Department of Transportation Boring Log indicates sandy topsoil atop clayey to sandy silt in the top five feet of soil in the general area of Willard Bay State Park. However, a general description of the surface soils in the Utah GMS report suggests that clayey silt and silty clay is widely distributed and occupies much of the park's land area.

**Site Hydrogeology**

According to the UT GMS, water either stands at the ground surface or is present within nine feet of the ground surface in most of the state park when the Willard Bay Reservoir is full. The shallow water table beneath the Site may fluctuate in response to changes in water level behind Willard Dam.

### 2.2.3 On- and Off-Site Land Uses

Willard Bay State Park is a recreational-use area. Facilities at the park include camping sites, boat launch ramps, marinas, and group-use areas. According to the Utah Department of Natural Resources, the park had 337,072 recreational visitors in 2011 (UT DNR 2013). Park workers and their families live at the park.

Willard Bay Reservoir is a source of fresh water for irrigation, drinking water, and recreation purposes for the area since its separation from the Great Salt Lake in the mid-1960s. However, the park's drinking water is supplied from the City of Willard.

The Bear River Migratory Bird Refuge is a 74,000-acre National Wildlife Refuge located directly north and northwest of the park. The refuge, along with other wetlands in the area, provides key habitat for over 250 migrating species of birds that rest and feed there annually. This Refuge is part of the Bear River Bay and is designated as a Western Hemisphere Shorebird Reserve Network site, a globally important shorebird area.

## 2.3 Aquatic Habitat Description

Figure 2 shows the location of the various aquatic habitats at Willard Bay State Park impacted by the March 18, 2013 pipeline rupture. Figure 4 shows the location of the background pond and creek area.

The impacted habitats at Willard Bay State Park consisted of three channel segments and four wetland areas, as follows:

- **Channel Segments**

The main channel segment is a nearly straight flow path running from east to west. Its water source, which is located on the east of Interstate-15 (I-15), is primarily derived from shallow groundwater discharge and land drainage (unimproved pasture). This water reaches the channel segments through a culvert under I-15. The channel banks are steep-sided, 3-5 meters (m) apart and roughly 2 m above the bed. The channel runs about 200 m west from the Park Access Road, before opening up within a beaver-pond wetland. The channel runs about 40 m to southbound I-15 east of the park access road. The channel is broken up by several sets of culverts between intersecting roads and park access trails (Hooker 2013).

The channel west of the Park Access Road is broken up into three segments by several sets of culverts located between intersecting roads and park access trails, as follows:

- *Channel Segment (CS) 1* represents the segment between the Park Access Road and southbound I-15. This area is closest to the ruptured pipeline. It is connected by culverts to the east and west.

- *CS 2* represents the segment between the Park Access Road and a park nature trail. It is the most eastern segment of the channel within the park proper. This segment is connected by culverts to CS 1 (to the east) and CS 3 (to the west).

- *CS 3* represents the segment between the park nature trails, which includes the (former) beaver diversion feeding into a wetland. It is connected by culverts to CS 2 (to the east) and the wetland complex (to the west).

- **Wetlands**

The impacted wetlands are primarily willow (*Salix*) shrub-scrub systems intermixed with freshwater marsh and shallow open-water areas. According to Utah DEQ, the wetlands appear to have developed into their current state fairly recently (after April 2005). The wetlands changed most likely from a willow-dominated riparian area to a more open water and marsh area after the channel was impounded by beavers.

- *Wetland Pond 1A* represents wetlands located right next to the pipeline rupture site. This area was excavated, the contaminated substrate was removed, and the area was back-

filled with clean soil and topped with a vegetative mat. Wetland Pond 1A is not directly connected to the other three wetlands.

- *Wetland Pond 1* represents a shallow depression inundated by beaver activity along the channel bank. It supports a shrub-scrub margin around open water, but has no direct surface outlet, except for sheet flow across the nature trail to the west.

- *Wetland Pond 2* represents two shallow depressions connected by surface water. Surface flow appears to enter the pond from the northeast portion of pond, where the channel opens into a pond; outflow occurs to the south directly to Willard Reservoir. In most Shoreline Clean-up and Assessment Technique (SCAT) survey reports, this area is divided into two wetland areas, namely 3/4 (to the north) and 3/4A (to the south). The wetland structure is generally the same as for Pond 3. It consists of areas of shallow open water with occasional patches of marsh vegetation surrounded with a scrub-willow margin.

- *Wetland Pond 3* represents a shallow inundated freshwater marsh, dominated by hard stem bulrush (*Scirpus acutus*) and patches of common cattails (*Typha latifolia*) and/or southern cattails (*Typha domingensis*), with hydrophytic-mesic pasture grasses and scrub-willow along the margins.

The three channel segments were evaluated collectively, as were Wetland Ponds 1, 2, and 3. Wetland Pond 1A was assessed separately due to the spatial division from the other wetland ponds by the Park Access Road.

- **Background Locations**

The background creek (Willow Creek) and the background pond are located about 1,400 feet north of the impacted area. They were chosen and agreed upon by DWQ and Chevron during a site visit in August 2013. The background creek and pond are believed to be the best representation of similar conditions at the impacted channel segments and wetland areas in Willard Bay State Park, and were not directly influenced by the pipeline release. The background creek flows from an outlet off Interstate I-15 and the background pond is connected to the creek. This general setup is similar to the impacted area (see Figure 4).

## 2.4 Data Acquisition

### 2.4.1 Suspected Site Contaminants

The analytes of interest to the SLERA were determined based on the known constituents of diesel fuel and the analytical results of previous sampling events at the Site (UDEQ 2013b). The major constituents of potential concern consisted of the following:

- Volatile Organic Compounds (VOCs) (e.g., trimethylbenzenes [1,2,3-trimethylbenzene, 1,2,4-trimethylbenzene, 1,3,5- trimethyl benzene], BTEX [benzene, toluene, ethylbenzene, and xylenes], naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, octadecane, n-propylbenzene, isopropylbenzene, and 4-isopropyltoluene);

- Semi-Volatile Organic Compounds (SVOCs), particularly PAHs;
- Total petroleum hydrocarbons - diesel range organics (TPH-DRO); and
- Aliphatic (i.e., straight-chained or branched) and aromatic hydrocarbon fractions.

Metals were excluded from the evaluation. Chevron submitted one pipeline diesel fuel sample collected after the pipeline rupture on March 18, 2013 and also analyzed a pipeline diesel fuel sample collected at the Site itself on March 19, 2013. Both samples were analyzed for 25 metals and metalloids. The concentrations of all the inorganic compounds measured in these two pipeline diesel samples fell below their reported detection limits. As a result, a consensus was reached among all the stakeholders that metals could be removed from the SLERA.

### 2.4.2 Sampling and Analysis

***June Sampling***

In June 2013, TechLaw collected sediment and surface water samples as outlined in the DWQ-approved June 10, 2013, *Final Uniform Federal Policy Quality Assurance Project Plan (June, UFP QAPP) for the Assessment of Potential Risk to Trespassers, Revision 1*. American West Analytical Laboratories (AWAL) in Salt Lake City, Utah analyzed the sediment and surface water samples for VOCs, SVOCs with PAHs, and DRO.

Surface water sampling took place on June 11 and 12, 2013 when the water levels of the channel segments and wetland ponds were drawn down as part of remedial efforts. Sediment samples were collected on June 6 and June 7, 2013. The sediment data were not included in the SLERA because Total Organic Carbon (TOC) was not measured. TOC allows bulk sediment contaminant levels to be converted into contaminant levels presented on the basis of TOC, which better reflects contaminant bioavailability to benthic invertebrates.

The purpose of the June sampling event was to assess the potential risk associated with a human trespasser accessing the fenced off area. Therefore, samples collection was targeted to be closer to the edge or outer banks of the wetland ponds and channel segments at locations thought to be the most likely paths or access points by a potential trespasser. The sample locations were identified by TechLaw based on field observations and were approved by Chevron's contracted field sampling firm (EarthFax Engineering, Inc.) and Chevron's additional sampling observer (CardnoENTRIX). All the stakeholders reached consensus that the surface water dataset could be used in the SLERA without the need for more sampling. During this time, additional surface water samples were also collected from the background pond and creek.

TechLaw collected 15 grab surface water samples and two duplicate samples at the Site and 10 grab surface water samples and two duplicate samples from the background locations. Figures 3 and 4 show the on-Site and background sampling locations, respectively.

***August 2013 Sampling***

In August 2013, TechLaw collected substrate samples as outlined in the DWQ-approved UFP *QAPP to Support Human Health and Ecological Risk Assessment, Revision 0,* dated August 20, 2013. AWAL in Salt Lake City, Utah analyzed the sediment samples for VOCs, SVOCs

with PAHs, and TPH-DRO. Accutest Laboratories in Orlando, Florida analyzed all the sediment samples for TOC.

Chevron obtained approval from DWQ to sample a few more selected locations from the June 2013 event for analysis of PAH and DRO in sediment.

Chevron also obtained approval from DWQ to submit aliquots of about 40 sediment samples collected from the channel segments and the wetlands in August 2013 for analysis of interstitial pore water at the Energy & Environmental Research Center at the University of North Dakota, Grand Forks, ND using ASTM method D 7363-07. The pore water samples were obtained in the laboratory by centrifugation, supernatant collection, and flocculation. Solid Phase Microextraction (SPME) was then used to remove the PAHs in each pore water sample using a polydimethylsiloxane-coated fused silica fiber. The SPME fibers were immediately desorbed in a gas chromatogram/gas spectrometer run in selected ion monitoring mode after the 30-minutes sorption phase was completed. The goal was to measure 34 dissolved PAHs consisting of 18 parent PAHs and 16 groups of alkylated daughter PAHs (see ASTM D 7363-07).

The PAH analytical results obtained from each pore water sample were converted to Toxic Units (TU = measured concentration/Final Chronic Value [FCV]). The FCVs were obtained from Table 3-4 in EPA (2003a). The PAH-specific TUs in each sample were then summed across the 34 PAHs (detected values only) to calculate a sample-specific $\Sigma$TU $PAH_{34}$. The EPA narcosis model (EPA, 2003a) predicts that a sediment sample will be toxic to benthic invertebrates if the $\Sigma$TU $PAH_{34}$ measured in its pore water equals or exceeds 1.0. More recent research published by McDonough *et al*. (2010) suggested that a $\Sigma$TU $PAH_{34}$ of 5.0 may be a less restrictive predictor of PAH toxicity. To help in the data evaluation, it was decided to use a $\Sigma$TU $PAH_{34}$ of 1.0 as a "no effect" threshold and a $\Sigma$TU $PAH_{34}$ of 5.0 as an "effect" threshold. The $\Sigma$TU $PAH_{34}$ values between 1.0 and 5.0 provided uncertain risk conclusions which may require further evaluation as part of future risk management discussions.

Twenty sediment samples were collected from the four wetland ponds. These samples represented two different strata, as follows:

- Wetland Pond Stratum 1- located within the wetland pond boundary, and
- Wetland Pond Stratum 2 – located along the upland wetland pond boundary outside the high water level mark.

In Ponds 1A, 1 and 3, three grab surface sediment samples were collected from within the wetland pond boundary and one surface sediment sample was collected at a random location along the upland wetland pond boundary. Wetland Pond 2 was nearly twice the size as the other ponds and hence six grab surface sediment samples were collected within the wetland pond boundary and two grab sediment samples were collected at random locations along the upland wetland pond boundary. Figure 3 shows the sampling locations at Wetland Ponds 1, 2, 3 and 1A.

Fifteen sediment samples were collected from the three channel segments. The samples were collected along a transect, with each transect representing three different strata, as follows:

- CS Stratum 1 – located at the bottom center of the channel segment;
- CS Stratum 2 – located about 0.3 m (1 ft) below the high water mark (i.e., "bathtub ring") from one side of the channel; and
- CS Stratum 3 – located at the upland boundary.

Three samples were collected along a single transect from CS 1, whereas six samples each were collected along two different transects from CS 2 and CS 3. Figure 3 shows the sampling locations at the Channel Segments.

***November 2013 Sampling Event***

In November 2013, TechLaw collected sediment samples as outlined in the DWQ-approved UFP *QAPP to Support Human Health and Ecological Risk Assessment, Addendum 2* dated November 4, 2013. A sheen was observed on the surface water in CS 3 during the August sampling event. Chevron performed proactive remedial measures at this location during the last week of October 2013, as outlined in Chevron's *Proposed Plan for Removal of Sheen from Sediment in CS 3*.

Ten sediment samples were recollected from CS-3 and analyzed by AWAL in Salt Lake City, Utah for VOCs, SVOCs with PAHs, and DRO. Accutest Laboratories in Orlando, Florida analyzed the sediment samples for TOC.

Chevron obtained approval from DWQ to recollect sediment samples from four locations visited during the June and August 2013 events for analysis of PAH and DRO. Chevron also provided 13 split sediment samples to the Energy & Environmental Research Center at the University of North Dakota, Grand Forks, ND for PAH pore water analysis. Finally, two sediment samples from Wetland Pond 2 were recollected for SVOC analysis because the analytical results from the August 2013 event were qualified and rejected.

### 2.4.3. Background Sample Locations

Figure 4 shows the background sampling locations in the creek and pond situated north of the impacted Site. Sediment and surface water samples were collected in August 2013.

***Background Sediment Samples***

Eight sediment samples were collected from the background pond. These samples represented two different strata, as follows:

- Background Wetland Pond Stratum 1- located in the wetland pond boundary (six background samples), and
- Background Wetland Pond Stratum 2 – located along the upland wetland pond boundary outside the high water level mark (two background samples).

Six sediment samples were collected from the background creek. The samples were collected along 2 different transects. Each transect represented three different strata, as follows:

- Background Creek Stratum 1 – located at the bottom center of the creek;
- Background Creek Stratum 2 – located about 0.3 m (1 ft) below the high water mark (i.e., "bathtub ring") from one side of the creek channel; and
- Background Creek Stratum 3 – located at the upland boundary.

***Background Surface Water Samples***

Four surface water samples were collected from the background creek and six more surface water samples were collected from the background pond.

The table below lists all the on-Site and background samples used in the SLERA.

| Aquatic habitat | Surface Water | Sediment |
|---|---|---|
| Channel Segment 1 | CS1-SW-01, CS1-SW02, CS1-SW-03, CS1-SW-04 (DUP) | CS1-SS-A-01, CS1-SS-A-02, CS1-SS-A-03, CS1-SS-A-04 (DUP) |
| Channel Segment 2 | CS2-SW-01, CS2-SW02, CS2-SW-03 | CS2-SS-A-01, CS2-SS-A-02, CS2-SS-A-03, CS2-SS-B-01, CS2-SS-B-02, CS2-SS-B-03 |
| Channel Segment 3 | CS3-SW-01, CS3-SW02 | CS3-SS-A-01, SC3-SS-A-02, CS3-SS-A-03, CS3-SS-A-08 (DUP), CS3-SS-B-01, CS3-SS-B-02, CS3-SS-B-03, CS3-SS-09 (DUP) |
| Wetland Pond 1 | WP1-SW-01, WP1-SW-02, WP1-SW-03 (DUP) | WP1-SS-04, WP1-SS-05, WP1-SS-06, WP1-SS-07, WP1-SS-08 (DUP) |
| Wetland Pond 2 | WP2-SW-01, WP2-SW-02, WP2-SW-03 | WP2-SS-07, WP2-SS-08, WP2-SS-09, WP2-SS-10, WP2-SS-11, WP2-SS-12, WP2-SS-13, WP2-SS-14, WP2-SS-15 (DUP) |
| Wetland Pond 3 | WP3-SW-01, WP3-SW-02 | WP2-SS-02, WP2-SS-03, WP2-SS-04, WP2-SS-05 |
| Wetland Pond 1A | No samples collected | WP1A-SS-05, WP1A-SS-06, WP1A-SS-07, WP1A-SS-08, WP1A-SS-10 (DUP) |
| Background Creek | WC-SW-01, WC-SW-02, WC-SW-03, WC-SW-06, WC-SW-07 (DUP) | WC-SS-A-01, WC-SS-A-01, WC-SS-A-02, WC-SS-A-03, WC-SS-B-01, WC-SS-B-02, WC-SS-B-03, WC-SS-B-O4 (DUP) |
| Background Pond | BP-SW-01, BP-SW-02, BP-SW-03, BP-SW-04, BP-SW-05, BP-SW-06, BP-SW-07 (DUP) | BP-SS-01, BP-SS-02, BP-SS-03, BP-SS-04, BP-SS-O5, BP-SS-06, BP-SS-07, BP-SS-08, BP-SS-09 (DUP) |

## 2.5 Data Evaluation

TechLaw validated the surface water and bulk sediment analytical data for use in the SLERA based on USEPA's National Functional Guidelines (NFGs) (EPA 1999, 2004) (Note: interstitial pore water data generated by Chevron and its contract laboratory were used as provided and did not undergo separate data validation by TechLaw). Newer NFGs are available, but the SW-846 methods were better represented by the earlier versions of NFGs. All of the surface water and bulk sediment chemistry data were subject to a Level III review, whereas 10% of randomly-selected data underwent a Level IV data validation. Validation qualifiers were assigned to the data to support interpretation and use.

An organic compound was assumed to be absent from surface water or bulk sediment if it was not detected in any sample (100% non-detect), the Method Detection Limit (MDL) met the data quality objectives, and ½ the maximum MDL fell below its surface water and/or bulk sediment screening criterion.

## 2.6 Ecological Resources

The ecological resources of concern to this SLERA are the aquatic community-level receptors directly exposed to residual diesel fuel compounds present in surface water and sediment in the channel and the wetlands. These receptors consist of benthic invertebrates, water-column invertebrates, fish, and the larval aquatic life stages of amphibians.

## 2.7 Screening-Level Fate and Effects Evaluation

A fate and transport evaluation of residual diesel fuel-derived compounds helps to identify potentially complete exposure pathways for consideration in the SLERA.

### 2.7.1 Fate and Transport

Information was reviewed to evaluate the potential fate and transport mechanisms that may result in complete exposure pathways. The evaluation determined if the following primary components of a complete exposure pathway were present in the channel and wetland Exposure Units (EUs):

- Sources of contamination
- Release and transport mechanism
- Contact point and exposure media
- Routes of entry

Each of these components is discussed below.

### 2.7.2 Sources of Contamination

UDEQ reported that substrate in the immediate area of the spill (including Pond 1A) were removed and confirmation samples were collected following the removal. The results of the confirmation samples indicated that the removal was successful (UDEQ 2013).

On April 9, 2013 Utah DEQ DWQ indicated that diesel-related hydrocarbons were detected just outside the last containment booms on Willard Bay. This observation suggested that shallow groundwater flowing into the reservoir may have been contaminated by the spill and that some of the contaminated groundwater or surface water from the site was bypassing the absorbent booms.

A French drain, which was constructed to intercept contaminated groundwater flowing into Willard Bay, was working as intended before the Site was dewatered. According to UDEQ DWQ, VOC analyses of samples collected from the area between the reservoir and the discharge from the beaver pond area resulted in one sample with concentrations of 1,2,3-trimethylbenzene at 2.6 µg/L. This level exceeded the detection limit of 2 µg/L. No other VOCs were detected at this location or at any of the other surface water sample locations (UDEQ 2013b). The French drains were removed after the Site was dewatered. Surface water was allowed to reflood the area because one of the restoration goals was to reestablish functional wetlands.

### 2.7.3 Release and Transport Mechanisms

Some of the diesel fuel from the ruptured pipeline flowed down the channel into the wetlands. Diesel components coated the sediment along the banks, interacted with the substrate and its pore water, and dissolved in the surface water. The more volatile fractions evaporated into the atmosphere, whereas other biodegraded over time.

Following the remedial efforts in the spring and summer of 2013, the following release and transport mechanisms may potentially affect the concentration and spatial distribution of residual diesel-fuel contamination in the waterways down-gradient from the pipeline rupture area.

- Migration of dissolved compounds in groundwater to sediment and surface water in adjacent surface water bodies, and its attenuation by dilution/dispersion and sorption,
- Transport of compounds adsorbed to soil particles via surface water runoff,
- Transport of dissolved compounds in surface water runoff, and
- Release of volatile compounds dissolved in surface water or present in sediment.

The potential for residual contamination to be released from sediment and transported to points of contact with aquatic receptors in the local waterways depends on volume released, significance of exposure, concentration, terrain/sheetflow/runoff features, presence of nearby surface water, extent and duration of contact with surface water, and spatial distribution within the habitats. Dissolution of residual hydrocarbons into the surface water/pore water and re-suspension of contaminated sediment particles in the water column are considered primary transport mechanisms for spill-related chemicals.

### 2.7.4 Contact Point and Exposure Media

The three channel segments and the four wetlands represent the potential contact points evaluated in the SLERA. Sediment and surface water in Willard Bay were removed from further consideration after it was shown that this water body was minimally affected by the diesel fuel spill.

As such, the exposure media of interest to this SLERA consisted of surface water and bulk sediment in the channel segments and the wetlands at the Willard Bay State Park. Pore water was also evaluated, but as a separate and independent line of evidence.

### 2.7.5 Routes of Entry

The main routes of entry for the community-level receptor groups in the aquatic habitats consisted of direct contact of residual contamination with surface water, sediment, and pore water, plus ingestion. The SLERA evaluated only direct contact because this pathway was assumed to represent the bulk of the total exposure. Adequate ecotoxicity data are available from the scientific literature only to address the potential for ecological risk associated with direct exposure (see **Section 4** for details), but not with ingestion in community-level ecological receptors.

### 2.7.6 Complete Exposure Pathways

The SCM (Figure 5) shows the potential exposure pathways linking residual diesel fuel-related hydrocarbons from their original source (i.e., the ruptured pipeline) and on-going source (impacted substrate) to community-level aquatic receptors down-gradient from the spill area.

The aquatic substrate represents the primary source of residual diesel fuel compounds in the channel segments and the wetlands under current (post-remedial) conditions. These petroleum hydrocarbons may adhere to sediment particles or dissolve into the sediment pore water where they may affect the benthic invertebrate community. Or they may emerge into the overlying surface water and affect the local fish and larval amphibians before biodegrading or volatilizing into the overlaying atmosphere.

The target receptor groups are exposed to residual diesel-related hydrocarbons mainly through direct contact with surface water, sediment, and pore water and secondarily through ingestion of food/prey that have accumulated some of these compounds in their tissues or via contaminated sediment particles. However, only the former is quantitatively assessed in the SLERA since no tools are available to quantify exposure in community-level receptors via ingestion.

## 2.8 Endpoint Selection

### 2.8.1 Assessment Endpoints and Risk Questions

The following assessment endpoints were used to evaluate the potential for ecological risks to the community-level aquatic receptors in the channel segments and the wetlands. A risk question is appended to each assessment endpoint.

It was assumed that by evaluating and protecting these assessment endpoints, all other community-level aquatic receptors in channel segments and the wetlands would be protected as well.

- **A stable and healthy benthic invertebrate community**: *Are the residual diesel-fuel contaminant levels in bulk sediment high enough to cause biologically-significant changes or impair the function of the benthic invertebrate community present in the substrate of the channel segments and wetlands at the Site?*

- **A stable and healthy water-column community**: *Are the residual diesel-fuel contaminant levels in surface water high enough to cause biologically-significant changes or impair the function of the water-column invertebrate community, fish community, and amphibian populations in the channel segments and wetlands at the Site?*

### 2.8.2 Measurement endpoints

The following measurement endpoints were selected to link quantifiable responses to their respective assessment endpoints. The results of the sediment pore water analyses (i.e., the $\Sigma$TU $PAH_{34}$ values) were not used as a separate measurement endpoint in the SLERA, but instead were interpreted independently in the risk characterization.

**A stable and healthy benthic invertebrate community**: *Are the residual diesel-fuel contaminant levels in bulk sediment high enough to cause biologically-significant changes or impair the function of the benthic invertebrate community present in the substrate of the channel segments and wetlands at the Site?*

One measurement endpoint was used to assess the potential impacts of diesel-related analytes in bulk sediment to this receptor group:

- Compare the analyte levels measured in bulk sediment samples to conservative sediment screening benchmarks.

**A stable and healthy water-column community**: *Are the residual diesel-fuel contaminant levels in surface water high enough to cause biologically-significant changes or impair the function of the water-column invertebrate community, fish community, and amphibian populations in the channel segments and wetlands at the Site?*

One measurement endpoint was used to assess the potential impacts of diesel-related analytes in surface water to these receptor groups:

- Compare the analyte levels measured in surface water samples to conservative surface water screening benchmarks.

### 2.8.3 Risk Question for the Willard Bay State Park SLERA

A risk question establishes the relationship between receptor groups and their predicted responses when exposed to Site-derived contaminants. They help understand what data are required to evaluate the potential for adverse effects to the receptor groups. The following general risk question was developed for this SLERA.

> *"Do the residual diesel fuel levels in surface water and sediment from the aquatic habitats of the channel segments and wetlands at the Willard Bay State Park reach or exceed levels that could adversely affect aquatic invertebrates, fish, and larval amphibians?"*

## 3.0 ECOLOGICAL EFFECTS EVALUATION AND COPEC SELECTION PROCESS

### 3.1 Screening Benchmarks

COPECs are chemicals present at concentrations that have the potential to affect the aquatic community-level ecological receptors identified earlier in this SLERA. COPECs are selected by comparing maximum contaminant levels measured in surface water and sediment against conservative screening benchmarks consisting of chronic SWBs and ESBs, respectively, the later adjusted for TOC.

The references for these benchmarks (in order of preference) are as follows:

*Surface water:*

- Table 3-4 in EPA. 2003. *Procedures for the derivation of equilibrium partitioning sediment benchmarks (ESBs) for the protection of benthic organisms: PAH mixtures*. EPA/600/R-02/013. November 2003.

- Table 3-1 in EPA. 2008. *Procedures for the derivation of equilibrium partitioning sediment benchmarks (ESBs) for the protection of benthic organisms: Compendium of tier 2 values for nonionic organics.* EPA/600/R-02/016.

- Tables 4 and 5 in MADEP. 2007. *Sediment toxicity of petroleum hydrocarbon fractions*. Prepared by Batelle. Available at www.mass.gov/dep/cleanup/laws/tphbat.pdf

- USEPA 2003. *Region V Ecological Screening Levels*. www.epa.gov/RCRIS-region-5/ca/ESL.pdf

Attachment 3.1 shows final chronic SWBs used to identify the surface water COPECs.

*Sediment:*

- Table 3-4 in EPA. 2003. *Procedures for the derivation of equilibrium partitioning sediment benchmarks (ESBs) for the protection of benthic organisms: PAH mixtures*. EPA/600/R-02/013. November 2003.

- Table 3-2 (Conventional ESBs) in EPA. 2008. *Procedures for the derivation of equilibrium partitioning sediment benchmarks (ESBs) for the protection of benthic organisms: Compendium of tier 2 values for nonionic organics*. EPA/600/R-02/016.

- Diesel fuel contains numerous fractions of aliphatic (i.e., straight-chained or branched) petroleum hydrocarbons which together form a complex mixture of compounds that can exert toxicity to aquatic community-level receptors. The aliphatic hydrocarbon fractions most likely associated with diesel fuel consist of $C_9$ to $C_{12}$, and $C_{13}$ to $C_{18}$. The available bulk sediment analytical data for aliphatics was compared to fraction-specific EqP sediment guidelines presented in Table 6 in MADEP (2007).

- The Equilibrium Partitioning (EqP) method was used to derive individual ESBs for analytes which lacked published ESBs in the three previous references. The general equation required to perform this calculation was as follows:

$$ESB = FCV * K_{oc} * f_{oc} \quad \text{(EPA, 1996)}$$

Where:

ESB = the concentration of a chemical in bulk sediment that, at equilibrium, results in a sediment pore water concentration equal to the chronic surface water screening value (µg/kg)

FCV = final chronic value for the target compound (µg/L)

$K_{oc}$ = organic carbon normalized partition coefficient for the target compound (L/kg OC)

$f_{oc}$ = fraction of organic carbon present in the sediment sample (g OC/g sediment)

The FCVs were the SWBs for VOCs and SVOCs provided in Attachment 3.1. The following equation was used to derive contaminant-specific $K_{oc}$s based on published n-octanol water partitioning coefficients (i.e., $K_{ow}$s).

$$\text{Log Koc} = 0.00028 + 0.938\text{Log Kow} \quad \text{(Di Toro } \textit{et al}\text{., 1991)}$$

$K_{ow}$s were obtained from the National Library of Medicine Hazardous Substances Data Bank (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB) or the Syracuse Research Corporation (SRC) ChemFate database (http://www.srcinc.com/what-we-do/efdb.aspx).

Fuchsman (2003) also showed that the % solids in a sediment sample should be considered when using the EqP model for organic contaminants with Log $K_{oc}$s below 3.5. The following equation was proposed to calculate ESBs for those contaminants that lacked published ESBs and had Log $K_{oc}$s below 3.5:

$$ESB = FCV * [(K_{oc} * f_{oc}) + ([1 - f_{solids}]/f_{solids})] \quad \text{(Fuchsman, 2003)}$$

Where:

$f_{solids}$ = fraction of solids in the sediment sample

This approach requires that the % solids in each sediment sample are available for use in the calculations.

Finally, all of the published and calculated ESBs are presented in terms of µg contaminant/kg OC. Appendices 6 and 7 provide the TOC data for the sediment samples used in the SLERA.

Attachment 3.2 shows final sediment ESBs for VOCs and SVOCs (including the aliphatic and aromatic fractions) used to identify the bulk sediment COPECs. The units of the sediment benchmarks presented in Attachment 3.2 were converted from mg/kg to µg/kg to facilitate comparison to the analytical datasets. Appendix 1 provides the calculations of ESBs by the EqP method for analytes lacking published sediment benchmarks.

## 3.2 Predicted Toxicity of the Sediment Pore Water

Attachment 3.3 summarizes the ΣTU $PAH_{34}$ values for the pore water extracted from sediment samples collected at the background location, the three channel segments and the four wetland ponds. The DRO levels associated with each of the sediment samples are provided for additional information.

## 3.3 COPEC Selection Decision Criteria

The following decision criteria were used to retain or exclude analytes in surface water and bulk sediment as preliminary COPECs for further evaluation in the SLERA.

*Surface water:*

Decision Criterion 1: An analyte was retained as a surface water COPEC if one of the following conditions were met:

- The maximum detected concentration of an analyte, or ½ the maximum MDL for a non-detected analyte, equaled or exceeded its chronic SWB.
- An analyte was present above its MDL but lacked a chronic SWB.

Decision Criterion 2: An analyte was excluded as a surface water COPEC if one of the following conditions were met:

- The maximum detected concentration of an analyte fell below its chronic SWB.
- ½ the maximum MDL for a non-detected analyte fell below its chronic SWB.

*Bulk sediment:*

Decision Criterion 1: An analyte was retained as a bulk sediment COPEC if one of the following conditions were met:

- The maximum detected concentration in bulk sediment, or ½ the maximum MDL for a non-detected analyte, equaled or exceeded its OC-normalized ESB.

- An analyte was present in bulk sediment above its MDL but lacked an ESB.

Decision Criterion 2: An analyte was excluded as a bulk sediment COPEC if one of the following conditions were met:

- The maximum detected concentration in bulk sediment fell below the contaminant's OC-normalized ESB.

- ½ the maximum MDL for a non-detected analyte fell below its OC-normalized ESB.

## 3.4 COPECs

### 3.4.1 Surface Water COPECs

Appendix 2 summarizes the surface water analytical data collected at the Site. These data focus specifically on diesel fuel-related compounds. 1-methylnaphthalene, 2-methylnaphthalene, indene, and naphthalene were present above their MDLs. A SWB was not available for 4-isopropyltoluene, 7,12-dimethylbenz(a)anthracene and Diesel Range Organics (DRO). ½ the MDL for a non-detected analyte, n-octodecane, exceeded its SWB. Attachment 3.4 summarizes the information for these analytes.

- The four detected analytes in surface water represented compounds likely found in diesel fuel. However, their maximum concentrations did not exceed their respective chronic SWB. As such, none of these analytes were retained as surface water COPECs.

- 4-Isopropyltoluene and 7, 12-dimethylbenz(a)anthracene were not detected in any of the fifteen surface water samples. Both constituents were retained as surface water COPECs for further evaluation based on the absence of SWBs.

- ½ the maximum MDL for n-octadecane exceeded its SWB. This analyte was retained as a surface water COPEC for further evaluation.

- DRO was not detected in the fifteen surface water samples collected as the Site. DRO lacks a SWB and was therefore retained as a surface water COPEC for further evaluation.

### 3.4.2 Bulk Sediment COPECs

Appendix 3 summarizes the analytical data from the bulk sediment samples collected at the Site. These data focus specifically on diesel fuel-related compounds.

***Wetland Ponds 1, 2, and 3***

Nineteen VOCs were present above their MDLs in one or more of the sediment samples collected from these three wetlands, along with n-octadecane and DRO. An ESB was not available for 4-isopropyltoluene or DRO. Attachment 3.5 summarizes the information for these analytes. The %TOC measured in the sediment sample with the maximum contaminant level as used to adjust the standardized (i.e., 1% TOC) benchmarks provided in Attachment 3.2.

- The nineteen detected VOCs represent compounds likely found in diesel fuel. However, their maximum concentrations did not exceed their respective ESBs. As such, none of these analytes were retained as sediment COPECs.

- 4-Isopropyltoluene was detected in four out of thirteen sediment samples while DRO was detected in sixteen out of sixteen sediment samples. Both analytes lack an ESB and were therefore retained as COPECs for further evaluation.

***Wetland Pond 1A***

Toluene, benz(a)anthracene, naphthalene, pyrene, and DRO were detected at least once in sediment samples from Wetland Pond 1A. 4-Isopropyltoluene was not detected but this compound, together with DRO, lacked an ESB. Attachment 3.6 summarizes the information for these analytes.

- Toluene, benz(a)anthracene, naphthalene, and pyrene were detected in one of four sediment samples. The maximum concentrations for these four analytes did not exceed their ESB. Hence, they were not retained as sediment COPECs.

- 4-Isopropyltoluene was not detected in the three sediment samples but lacked an ESB. Hence, this analyte was retained as a sediment COPEC for further evaluation.

- DRO was detected in four out of four sediment samples but lacked an ESB. Hence, this analyte was also retained as a sediment COPEC for further evaluation.

***Channel Segments***

Twenty-two VOCs were detected above their MDLs in sediment from Channel Segments 1, 2, and 3. Two SVOCs, n-decane, and n-octadecane were also detected above their MDLs, along with two PAHs (fluoranthene and pyrene) and DRO. 4-Isopropyltoluene and DRO lacked ESBs. Attachment 3.7 summarizes the information for these analytes.

- The 21 detected VOCs represent compounds likely found in diesel fuel. However, the maximum concentrations of these analytes did not exceed their respective ESBs. Hence, none of these analytes were retained as sediment COPECs. 4-Isopropyltoluene lacked an ESB and was therefore retained as a COPEC for further evaluation.

- N-Decane and n-octadecane were detected in two and seven out of 15 samples, respectively. However, their maximum concentrations did not exceed their respective ESBs. Hence, these two analytes were not retained as COPECs.

- Fluoranthene and pyrene were detected above their MDLs in one and three out of 15 samples, respectively. The maximum concentrations of these analytes did not exceed the ESBs. Hence, they were not retained as COPECs.

- DRO was detected in 15 of 15 sediment samples but lacked an ESB. Hence, DRO was retained as a sediment COPEC for further evaluation.

# 4.0 SCREENING-LEVEL EXPOSURE ESTIMATES

## 4.1 Exposure Units and Exposure Concentrations

Ideally, each channel segment and wetland would be its own surface water and sediment Exposure Unit (EU) and would be evaluated independently of all the others to see if the risk at any of these locations is acceptable or not. However, the data structure precludes this approach because location-specific datasets were too small and contained too many non-detects. As a result, analytical data were combined across adjacent habitats, as explained below, in order to obtain robust datasets.

### 4.1.1 Surface Water

Less than 20 surface water samples were collected in June 2013 across all the aquatic habitats at the site. The original intent was to combine all these data points into a single dataset to derive EPCs. However, EPCs did not need to be calculated for use in the risk characterization because no surface water compounds were identified as COPECs.

### 4.1.2 Sediment

Numerous sediment samples were collected from the three channel segments and the four wetlands in August through November of 2013. An initial attempt was made to determine if individual channel segments and wetlands could serve as their own sediment EUs by using ProUCL to derive 95% UCLs to represent EPCs. The individual datasets were either too small or contained too many non-detects to generate these values.

Instead, the sediment analytical data for Wetland Ponds 1, 2, and 3, were combined to characterize one EU and the three channel segments were combined to characterize a second EU. Wetland Pond 1A remained a separate EU. However, the initial screening process did not identify any detected sediment COPECs that would require EPCs for use in the risk characterization. EPCs were not calculated for the two sediment COPECs because neither 4-isopropyltolune or DRO have screening benchmarks.

# 5.0 RISK CHARACTERIZATION

## 5.1 Introduction

The potential for ecological risk is quantified during risk characterization. This phase, which represents the last stage of the SLERA, is typically built around three sequential steps: 1) risk estimation; 2) uncertainty analysis; and 3) risk description.

The exposure analysis and effects analysis are integrated during risk estimation to determine the likelihood of adverse effects to the assessment endpoints, given the assumptions inherent in the analysis phase. The uncertainty analysis provides a context for the influences of those assumptions on the risk characterization process. Finally, the risk findings are summarized, interpreted, and discussed using the available evidence to address the risk estimates and the uncertainties associated with them.

The risk characterization for this SLERA was greatly simplified because all of the surface water and sediment COPECs were either non-detect, or lacked screening benchmarks. Hence, it was not possible to further refine these analytes by either calculating less conservative EPCs or using less conservative benchmarks. The discussion below was based on an evaluation of the available data, followed by a description of the major uncertainties associated with the SLERA process. Attachment 5.1 summarizes the outcome of this process.

## 5.2 Surface Water

Four analytes were retained as surface water COPECs (see Attachment 3.4). 4-Isopropyltoluene and 7, 12-dimethylbenz(a)anthracene were not detected in any of the on-Site surface water samples but both lacked SWBs. Neither analyte was detected in any background surface water sample (see Appendix 4**)**. n-Octadecane was not detected in any of the 15 on-Site surface water samples but ½ its maximum MDL exceeded its SWB. DRO was not detected in any of the on-Site surface water samples but this analyte was also retained as a site COPEC based on the absence of a SWB.

It was concluded that these four analytes were unlikely to represent actionable risk due to their absence from on-Site surface water samples. This conclusion had high uncertainty for n-octadecane because ½ its MDL of 0.401 µg/L exceeded its SWB of 0.013 µg/L by over two orders of magnitude.

## 5.3 Bulk Sediment

Only 4-isopropyltoluene and DRO were consistently retained as COPECs in sediment samples from the three sediment EUs (i.e., Wetland Ponds 1, 2 and 3, Wetland Pond 1A, and the Channel Segments), all due to a lack of applicable benchmarks. All other analytes were removed from further consideration as COPECs because either the maximum detected concentration or ½ the maximum MDL for non-detect results did not exceed the ESBs.

The ProUCL software (version 5.0.00, US EPA, 2013) was used to calculate two DRO Upper Tolerance Limits (UTLs) using the analytical data from the background pond and background creek sediment samples (see Appendices 8 and 9). These two values, which equaled 232,000 µg/kg and 143,000 µg/kg, respectively, also represented the maximum detected sediment DRO levels measured at both background locations (see Attachments 3.8 and 3.9). Note that, in the absence of a DRO sediment screening benchmark, on-site detections of DRO which exceed the UTL do not indicate the presence of excess ecological risk. Rather, the comparison suggests that DRO levels are likely to be exacerbated by spill-related residual concentrations.

### 5.3.1 Wetland Ponds 1, 2 and 3

4-Isopropyltoluene was detected in four out of 13 sediment samples collected from this EU. This aromatic compound consists of 10 carbons, which places it in the same category as the $C_9$ to $C_{12}$ aromatic hydrocarbon fraction for which the Massachusetts Department of Environmental Protection developed a generic sediment ESB of 230 µg/kg (@ 1% TOC). This information showed that the maximum detected concentration of 4-isopropyltoluene (4.57 ug/kg with 0.526% TOC) in sediment samples collected from this EU most likely did not represent unacceptable risk to the local benthic invertebrate community. Therefore, this analyte was removed from further consideration.

DRO was detected in all 16 sediment samples, with a maximum detected concentration of 438,000 ug/kg at sample location WP2-SS-12. A duplicate sample (WP2-SS-15) collected at this location showed 198,000 ug/kg DRO. Except for the 438,000 µg/kg DRO at WP2-SS-12, all other DRO levels in the sediment samples from Wetland Ponds 1, 2, and 3 fell below the UTL of 232,000 µg/kg. This pattern suggested that, with one exception, the presence of DRO in sediment collected from Wetland Ponds 1, 2, and 3 mostly reflected background conditions.

### 5.3.2 Wetland Pond 1A

4-Isopropyltoluene was not detected in any of the sediment samples collected from this EU. ½ the MDL equaled 0.16 µg/kg (@ 0.73% TOC), which fell well below the generic ESB of 230 µg/kg (@ 1% TOC). Therefore, this analyte was removed from further consideration.

DRO was detected in all the sediment samples collected from this EU. The maximum DRO concentration (52,300 ug/kg) was much lower than the background UTL of 232,000 ug/kg. This information suggested that the DRO levels measured in the Wetland Pond 1A sediment reflected background conditions and were of no further concern.

### 5.3.3 Channel Segments 1, 2 and 3

4-isopropyltoluene was detected in seven of the 13 sediment samples collected from this EU at a maximum detected concentration of 36.1 µg/kg (@ 1.63% TOC),

which fell well below the generic ESB of 230 µg/kg (@ 1% TOC). Therefore, this analyte was removed from further consideration.

DRO was detected in all 15 of the Channel Segment sediment samples. The background creek sediment UTL for DRO was 141,000 µg/kg.

- *Channel Segment 1*: The highest sediment DRO level equaled 83,800 µg/kg, which fell below the background creek UTL. The DRO levels within this channel segment most likely represented background. This analyte was removed from further consideration.

- *Channel Segment 2*: The highest sediment DRO level (2,820,000 µg/kg) was measured at CS2-SS-B-03. This value exceeded the background creek DRO UTL of 141,000 µg/kg by 20 times. The ΣTU $PAH_{34}$ for this sample equaled 20.4 which predicted toxicity to benthic invertebrates. However, sample locations CS2-SS-B01 and CS2-SS-B02, found next to CS2-SS-B03, had DRO levels of 42,100 µg/kg and 56,300 ug/kg, respectively, which were representative of background. This pattern likely indicated a localized DRO "hot spot". A second DRO UTL exceedance was observed at CS2-SS-A-02 (243,000 µg/kg). The ΣTU $PAH_{34}$ for this sample equaled 16, which also predicted toxicity to benthic invertebrates. DRO in Channel Segment 2 could not be eliminated as a COPEC and may require further evaluation as part of the risk management decision process.

- *Channel Segment 3*: The sediment DRO levels at five of the six sampling locations in Segment Channel 3 exceeded the background creek UTL of 141,000 µg/kg. These exceedances ranged from 143,000 µg/kg to 900,000 µg/kg. Pore water was collected from four of the six sediment sampling locations in this channel segment to measure ΣTU $PAH_{34}$. The pore water from the three sediment samples with DRO levels above the background Creek UTL was predicted to be non-toxic, whereas the fourth sediment sample (CS3-SS-A-01-R), with a DRO level of 138,000 µg/kg, was predicted to have highly-toxic pore water (ΣTU $PAH_{34}$ = 34). DRO in Channel Segment 3 could not be eliminated as a COPEC and may require further evaluation as part of the risk management decision process.

DRO in sediment remained as a major uncertainty due to a lack of a screening benchmark, the presence of DRO at several sampling location in excess of background concentrations, and several ΣTU $PAH_{34}$ measures above 5.0.

## 5.4 Uncertainties

The SLERA provided a conservative evaluation to assess the potential for ecological risk to water column and benthic community-level receptors in the waterways at Willard Bay State Park affected by the diesel fuel spill of March 2013. Uncertainty was addressed by incorporating conservative bias, where practical, to minimize the

possibility of overlooking excess ecological risk, if present. The following subsections describe the major sources of uncertainty associated with each of the major SLERA steps.

***Screening-Level Problem Formulation***

- The Site and its aquatic habitats were fully investigated as part of the site investigation process. It is deemed highly unlikely that other spill-related compounds not already identified were present in the affected waterways.

- The ecological receptors selected for evaluation represented generic groups of invertebrate and vertebrate organisms that may be exposed to spill-derived compounds. It is possible, but unlikely, that one or more of the impacted waterways supports a particularly sensitive community-level species which is affected more than those evaluated in this SLERA. Overall, it is anticipated that the receptor groups used as assessment endpoints represented the major aquatic communities that may be present in the waterways now or in the future.

- The SCM was based on extensive chemical analyses performed after the spill. The major source of Site-related contamination was known, the major exposure pathways were verified, and the receptor groups were plausible and expected, given the types of habitats present at the Site. It was therefore unlikely that the SCM misrepresented the overall conditions at the Site.

- The surface water samples were collected in June of 2013, whereas additional remedial efforts took place throughout the wetlands and at channel segment 3 during the summer and fall of 2013. As such, it was expected that the surface water samples collected in June represented "worse-case" exposures when compared to later conditions. The fact that the surface water analytical data showed little or no spill-related contamination strongly suggested that surface water exposure was not a concern at the Site.

- The locations of most sediment samples collected from the channel segments and the wetlands were determined on a random basis. In addition, a subset of these samples were collected using a "biased" sampling approach based on visual (e.g., sheens) or olfactory cues identified during the field sampling process. As such, it was deemed unlikely that the analytical datasets used in the SLERA grossly misrepresented the general conditions prevailing at the Site, even though the data showed that isolated "hot spots" may still be present.

***Screening-Level Ecological Effects Evaluation***

- The screening-level ecological effects evaluation was based entirely on no-adverse-effect screening benchmarks published in the literature or derived using EPA-approved methods. These benchmarks, by definition, are conservative and intended to protect all individual receptors from long-term harm. While all available benchmarks used for COPEC selection were based on generic toxicological data (particularly the sediment values), the conservatism inherent in

their derivation was expected to prevent chemicals from being inappropriately eliminated as COPECs.

- A major uncertainty with the ecological effects evaluation was the lack of a published sediment benchmark for DRO. This "compound", which directly reflects diesel-related fuel, was consistently detected in all sediment samples collected from the wetlands and the channel segments at the Site. However, DRO was also detected in the background sediment samples, strongly suggesting that at least some of the on-Site DRO may have originated from sources other than the pipeline release. The most likely source appears to be runoff from I-15 running just to the east of Willard Bay State Park. The lack of a benchmark prevented the SLERA from determining if the DRO levels measured in on-Site sediment represented a potential risk concern. This data gap represented a substantial uncertainty.

- The pore water analytical data, presented in terms of ΣTU $PAH_{34}$ values, identified the potential for toxicity associated with PAHs only. A regression was performed (not shown) to determine if ΣTU $PAH_{34}$ could be used to predict DRO levels. The results showed that one variable could not predict the other. This outcome was not surprising since PAHs only make up a very minor fraction of diesel fuel. But it also highlighted the fact that sediment samples with ΣTU $PAH_{34} < 1.0$ could not automatically be assumed to be *non-toxic* since this measure focused exclusively on 34 PAHs and ignored all of the other petroleum hydrocarbons associated with DRO which could be toxic via general narcosis. This uncertainty is substantial and may need to be further considered in the risk management decision-making process

- Section 3.1 discussed including a correction factor based on % solids to calculate ESBs for organic contaminants with Log $K_{oc}$s below 3.5. This correction was not used when deriving the ESBs due to a technical oversight. Subsequent calculations showed that including % solids in the equation caused minor changes in the ESBs which would not have altered the existing conclusions in any way.

***Screening-level exposure estimate***

- The EPCs are represented by the constituent-specific maximum detected concentration or ½ the maximum MDL for non-detected compounds in the sediment and surface water samples collected from the aquatic habitats at the Site. Maximum detected concentration-based EPCs, by definition, represent "worst case" estimates of site conditions which were nonetheless assumed to reflect an entire exposure area. This approach is conservative and ensures that ecological risk is unlikely to be underestimated.

- The detection of DRO in the substrate used to backfill Wetland Pond 1A was unexpected. The levels did not exceed the prevailing background concentrations but nonetheless did not represent pristine conditions. It is unknown if the DRO

levels measured in the Pond 1A substrate were generated by the local background conditions or represented the site conditions which adversely affected the fill when it was added to the restored wetland. This situation did not affect the outcome of the risk characterization.

## 5.5 Proposed Scientific Management Decision Point (SMDP)

The Ecological Risk Assessment Guidance for Superfund (ERAGS) (USEPA, 1997) defines the risk management option associated with the SLERA tier (Steps 1 and 2) of the ecological risk assessment process. The risk manager uses the results of the SLERA to address the SMDP. The following three decisions are possible:

- The available information is sufficient to conclude negligible risks and there is no need for further action.

- The available information is not sufficient to make a defensible risk decision and the ERA process continues.

- The available information indicates the potential for risk and further assessment is warranted.

It is concluded, based on the outcome of this SLERA, that the potential risk to the aquatic community receptors exposed to surface water at Willard Bay State Park is negligible.

It is also concluded that DRO in sediment remains as a major uncertainty due to a lack of a screening benchmark to determine effect. The presence of DRO above background levels in sediment at several sampling locations and with several $\Sigma$TU $PAH_{34}$ measures in excess of 5.0 suggests the potential for unquantified ecological risk to the benthic invertebrate community at select locations. This outcome may indicate the need for additional scrutiny.

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# FIGURES

# ATTACHMENTS

# APPENDICES