

Pathway to Closure for a Heavy Oil Release into the North Saskatchewan River

Tara Murfitt, P.Geo.

Shaun Toner, P.Biol., PMP

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Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Outline

- Overview of release
- Overview of legislation
- Regulatory framework and consultation
- Five steps to closure



Acknowledgements

Emergency Response, Initial Cleanup

Large, multi-disciplinary and dynamic response effort

~1,200,000 hours spent

2,500 people (including dozens of consulting teams / Indigenous groups)

Follow-up Site Assessment, Risk Assessment, Validation and Closure

Shoreline Cleanup Assessment (SCAT): Owens Response Group

Forensic Chemistry: Chemistry Matters

Aquatic Ecology: SLR Consulting

Provincial Regulators: Ministry of Environment and Water Security Agency

Federal Regulators: Environment and Climate Change Canada

Release Overview

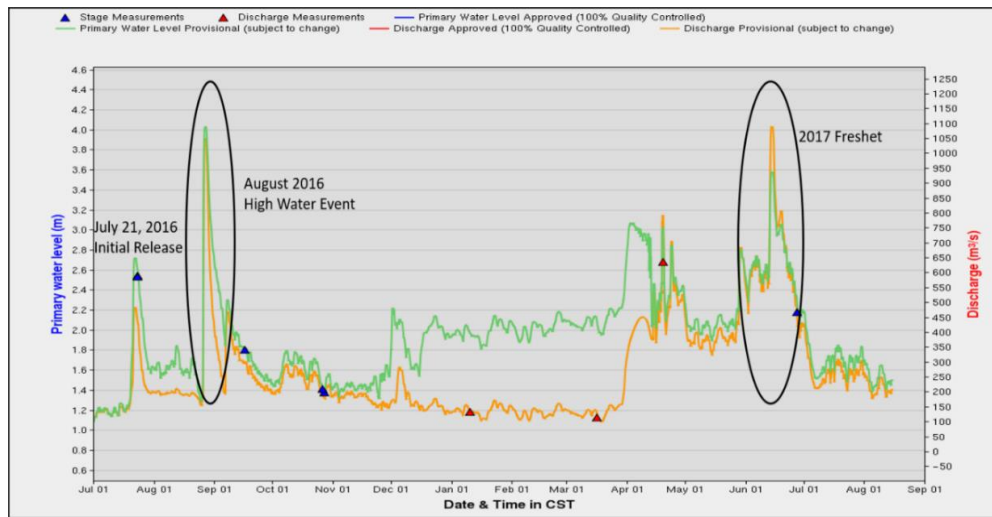
July 21, 2016: Oil leak near the North Saskatchewan River

225 m³ (+/- 10%) crude oil blended with condensate

Break occurred on land, 160 m from the south bank

~60% of the product contained on land

Discharge at time of release – 300 m³/s to 650 m³/s



Release Overview

North Saskatchewan River - Drainage Area:

- Nelson River Basin: over 1 million km² (10% of Canada)
- North Saskatchewan River: 140,000 km²

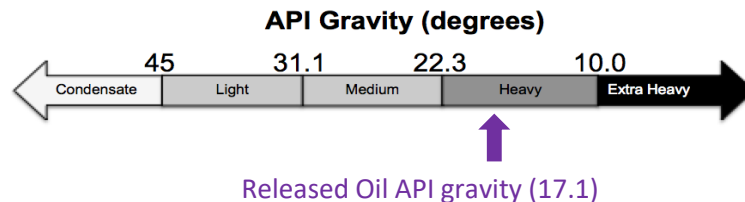
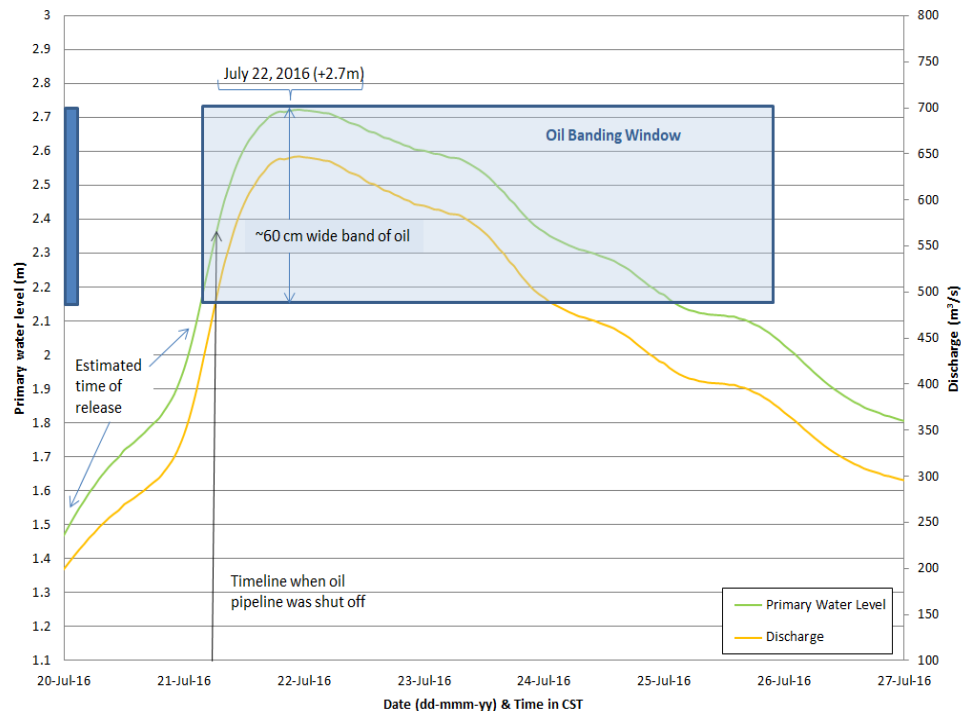
~600 km downstream of the point of entry (across most of Saskatchewan)

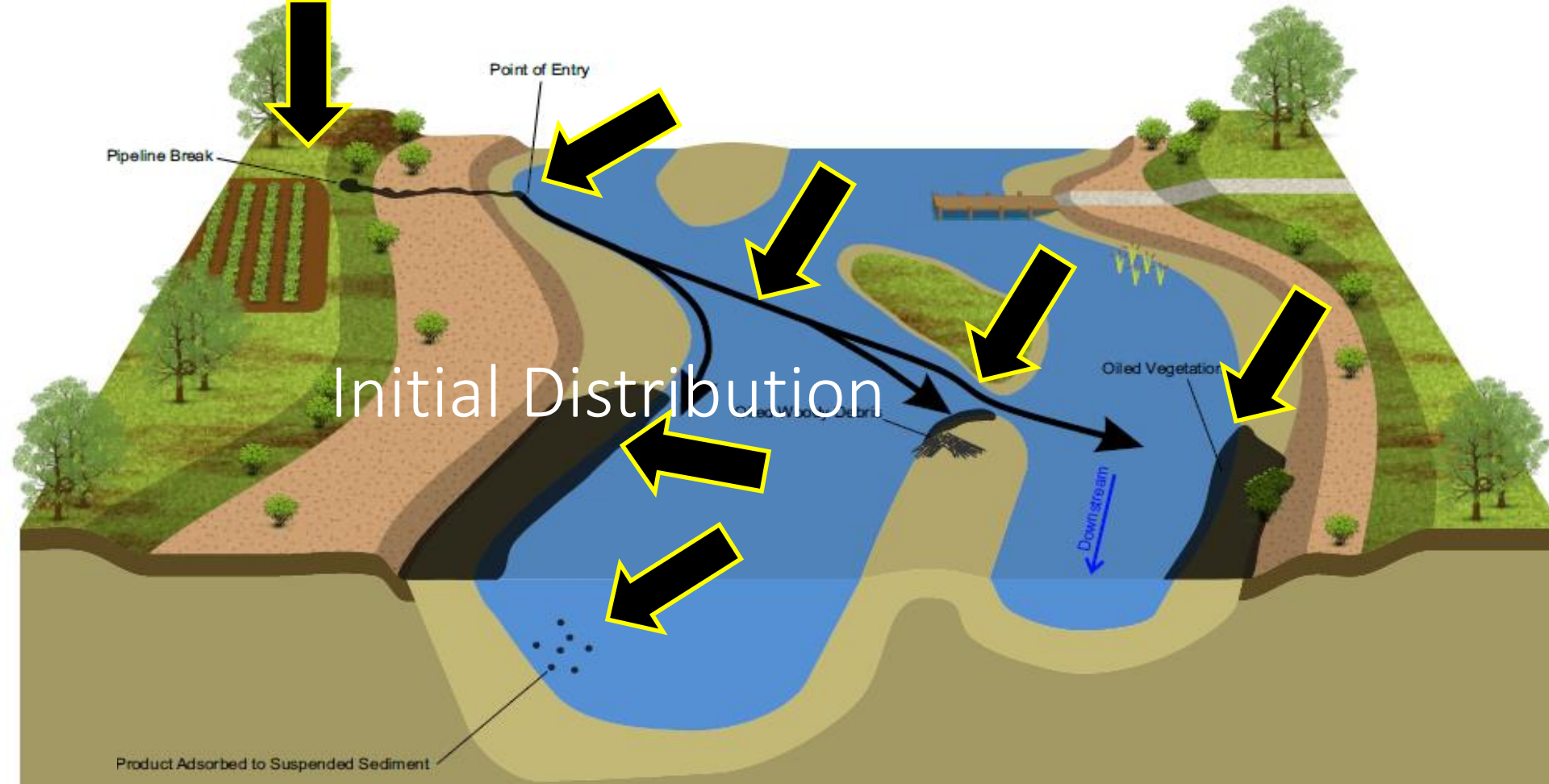
North Battleford, Prince Albert and Melfort – Major municipal water consumers



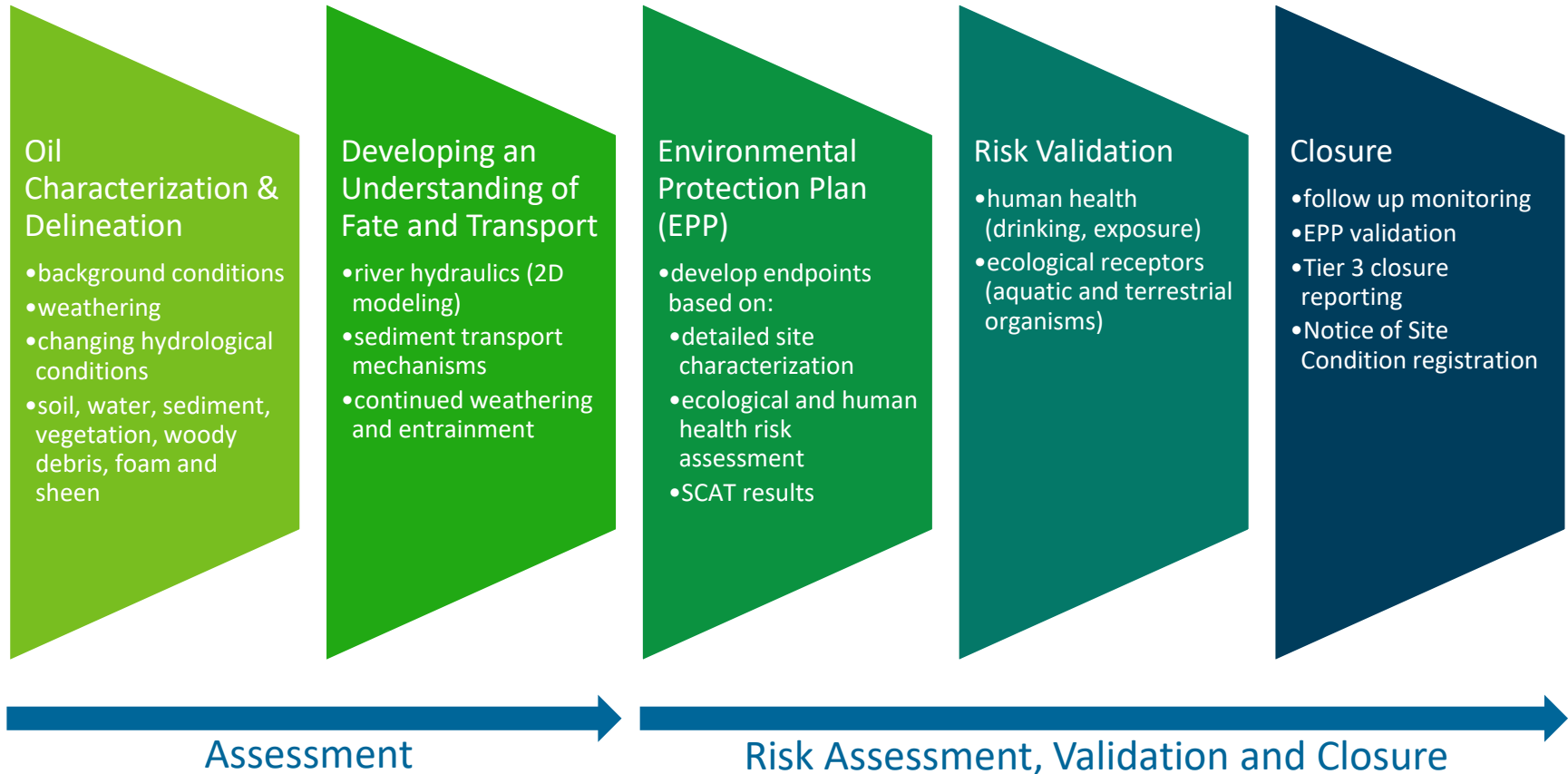
Release Overview

- Oil less dense than water at temperatures over 5°C
- Intermittent band of oil for 43 km along shoreline (cleaned in July/August 2016)
- High water event in late August 2016 redistributed residual oil
 - Found along shoreline for 100 km
 - Oiled woody debris found up to 480 km downstream





The Path to Closure



Regulatory Framework

- *Saskatchewan Environmental Code - Division B: Land Management and Protection*
- *Guidelines for Preparation of an Environmental Protection Plan (EPP) for Oil and Gas Projects: Procedures under the Environmental Assessment Act (Saskatchewan)*
 - Provided a structure for the EPP but it was focused on pre-development work (not impacted sites)
 - Worked closely with regulators to adapt the EPP structure to impacted sites

Regulatory Framework

Guidance Document: Impacted Sites provided closure endpoints



Tier 1: use established criteria based on limited site-specific knowledge



Tier 2: endpoints specific to exposure scenarios and pathways, based on more detailed knowledge

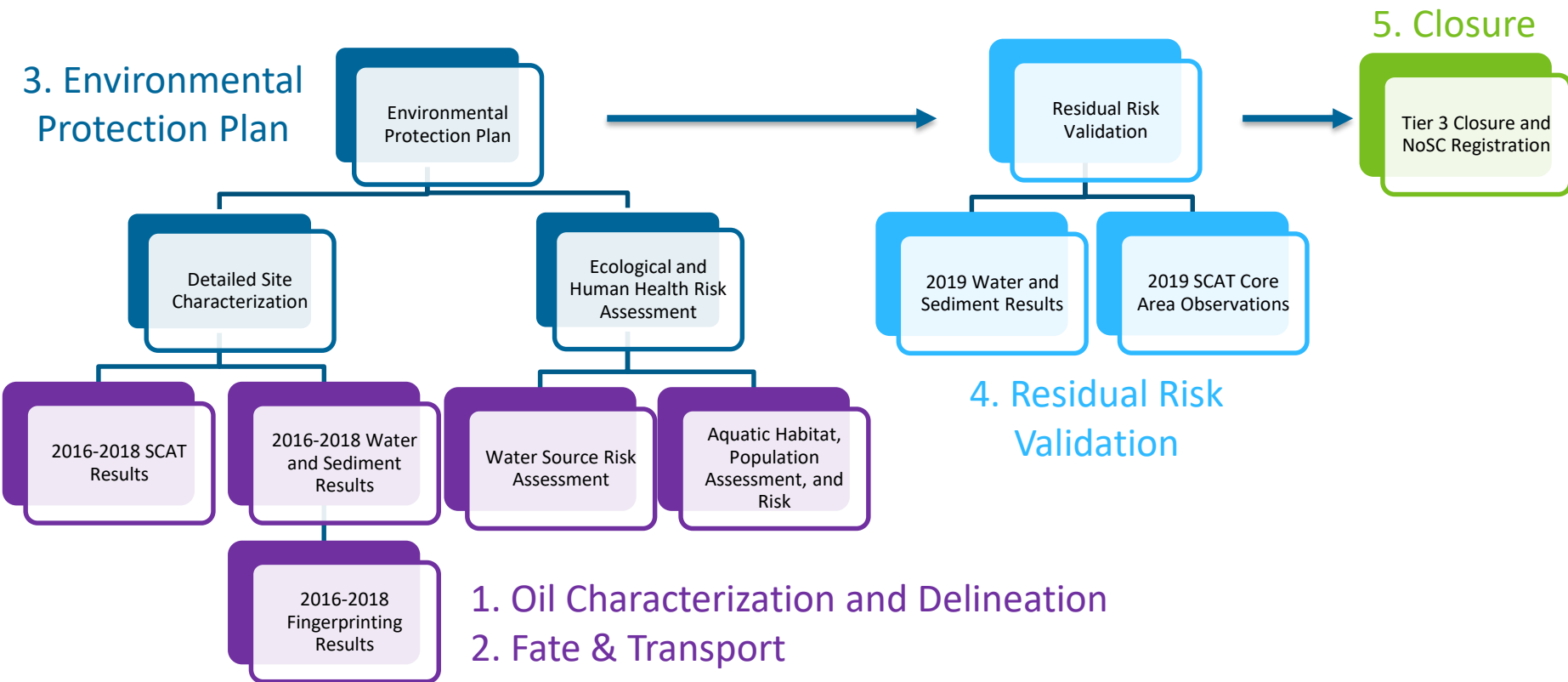


Tier 3: endpoints selected based on complexity of the impacted site

Tier 3 Endpoints

- Developed through *Endpoint Selection Standard*
- Site-specific criteria used to determine endpoints
 - Required detailed understanding of site
 - Approach must have met the Results Based Objectives (RBOs)
- Due to site complexity, an ecological and human health risk assessment was required to confirm certain endpoints met
- Required sign-off by Qualified Person (QP) to demonstrate endpoints were met.

Closure Process



Field Program Overview

Program	Sample Type	2016	2017	2018	2019
Break Point Remediation	Soil	excavation of 590 m ² of soil for pipeline repair and excavation of 3,680 m ² of soil for overland release path remediation	excavation of 150 m ² of soil for pipeline replacement and supplemental spill path remediation	no further remediation required	
SCAT/Shoreline Remediation	Soil/Sediment Survey/Treatment	from KPO to KP178 and additional segments up to KP486	from KPO to KP486	survey only from KPO to KP20	survey only from KPO to KP20
Water Sampling	Surface Water	4,655 samples	408 samples	227 samples	64 samples
	Passive Monitoring	20 samples (ultra-low concentrations of polycyclic aromatic hydrocarbons and naphthenic acids)	sampling program discontinued		
	Foam	43 samples	1 sample	sampling program discontinued	
	Sheen	26 samples	3 samples	sampling program discontinued	
	SODD	1,100 observations	640 observations	monitoring program discontinued	
	Groundwater	31 samples	sampling program discontinued		
	Leachate	no leachate samples collected	8 TCLP samples	2 pore water samples	8 pore water samples
Sediment Sampling	Dredge	670 samples	205 samples	68 samples	61 samples
	Core	21 samples	138 samples	117 samples	57 samples
	Sediment Sock	543 samples	sampling program discontinued		
Ecological Monitoring	Vegetation	qualitative willows sheening	2 rat root samples	sampling program discontinued	
	Terrestrial Wildlife	deterrents deployed along KPO to KP36, 55 wildlife individuals recovered, 22 beaver lodges cleaned	qualitative assessment of the sites investigated in 2016	monitoring program discontinued	
	Aquatic Community	27 sites surveyed for fish and 8 of those sites for benthic macroinvertebrates	27 sites surveyed for both fish and benthic macroinvertebrates	sampling program discontinued	

Detailed Site Characterization Results Based Objectives

2016	2017-2019
SCAT Manual	Saskatchewan Environmental Code
No Further Treatment Endpoints	Results-Based Objectives (Chapter B.1.2)
Shoreline Treatment Recommendations	Corrective Action Plans (Chapter B.1.3)
SCAT Surveys	Visual Site Assessments (Chapter B.1.3)

RBOs developed as cleanup endpoints

- Surface oiling (river banks and channel margins)
- Subsurface sediments

Several cleanup actions

- Residual oil removal
- Stained vegetation, surface / subsurface sediment removal
- Sediment causing sheen removal

Detailed Site Characterization

Treatment Endpoints



No observed oil: Endpoint met



Meets RBOs: Endpoint met



Does not meet RBOs: Endpoint not met

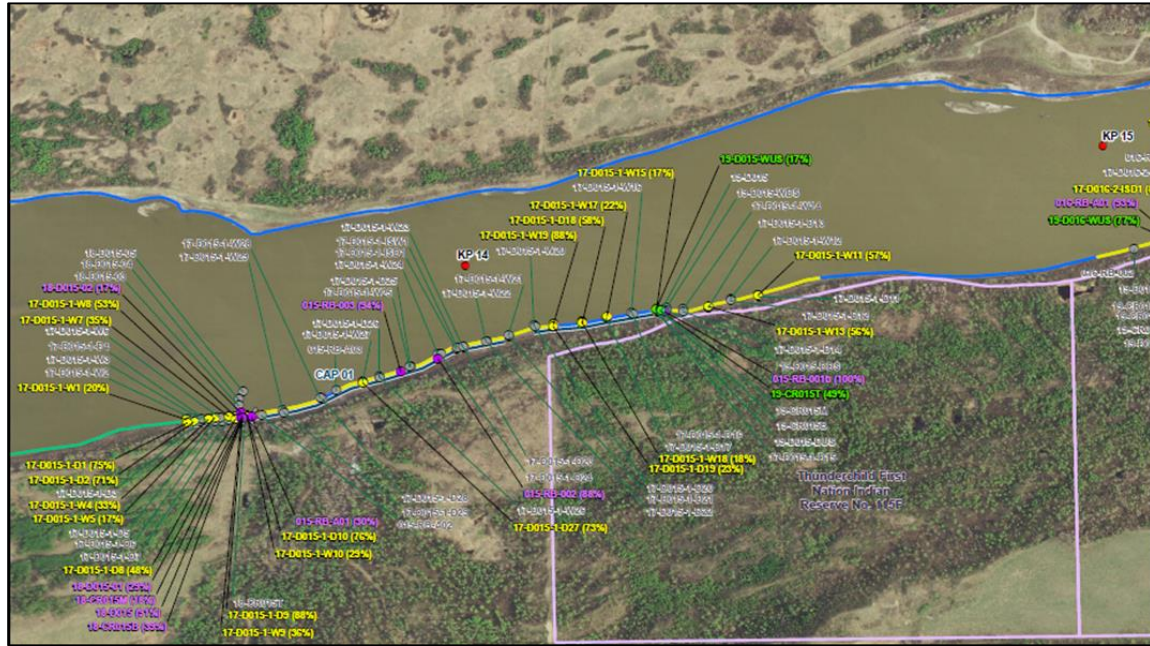
- Complete-As-You-Go (CAYG): Simple treatment / endpoint then met
- Corrective Action Plan (CAP): Complex treatment / endpoint then reassessed
- No Further Treatment (NFT): Endpoint cannot be met
 - Negative net environmental benefit (NEB)
 - As low as reasonably practicable (ALARP)
 - Safety concern

Detailed Site Characterization Shoreline Cleanup

Approximately 960 km of
shoreline was surveyed

The majority of shoreline
surveyed in 2016 was
resurveyed in 2017

Further monitoring of CAP
and NFT areas was conducted
in 2018 and 2019

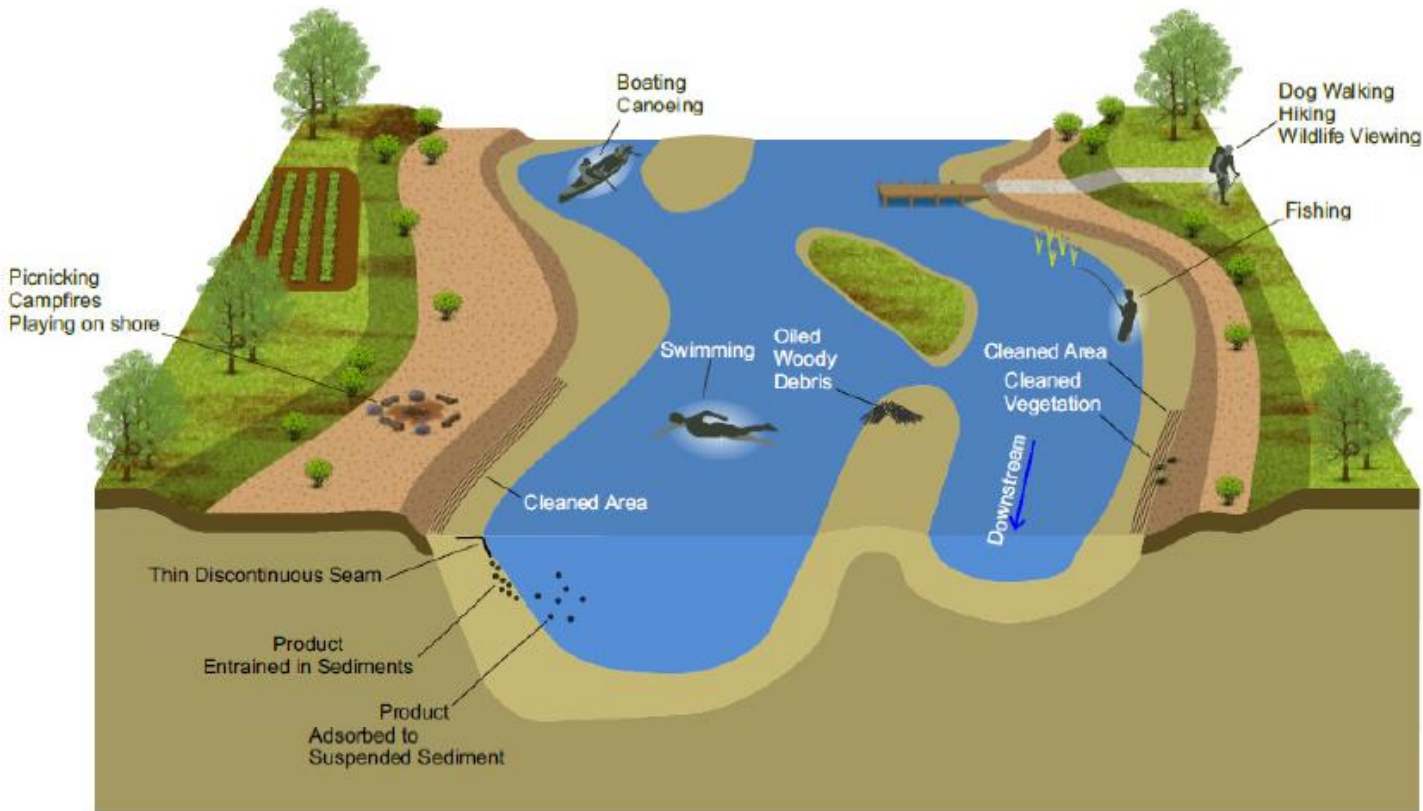


KP ¹	Segment	CAP or CAYG	NFT Based On	Length (m)
No Further Treatment Zones in the Core Area Division				
1	1-001-RB	5	NEB	58
				81
2	1-002-RB	6	NEB	119
				183
7	1-009-RB	7	NEB	41
14	1-015-RB	1	NEB	16
				202
				266
				335
15	1-016-RB	2	NEB	184
				261
				122
				15
TOTALS				1,884
No Further Treatment Zones Outside the Core Area Division				
27	1-029-RB	16	ALARP	167
32	1-034a-MC	CAYG ²	ALARP	336
72	2-075-LB	CAYG ³	SAFETY	26
120	3-125-LB	CAYG ⁴	ALARP	160
TOTALS				689
No Further Treatment Zones in Study Area				
TOTALS				2,573

Detailed Site Characterization Corrective Action Plans (SCAT)

- 54 CAP areas were identified from KP0 to KP217
- CAPs covered approx. 9.6 km of shoreline
 - 7.1 km met RBOs
 - 2.5 km NFT (post treatment)

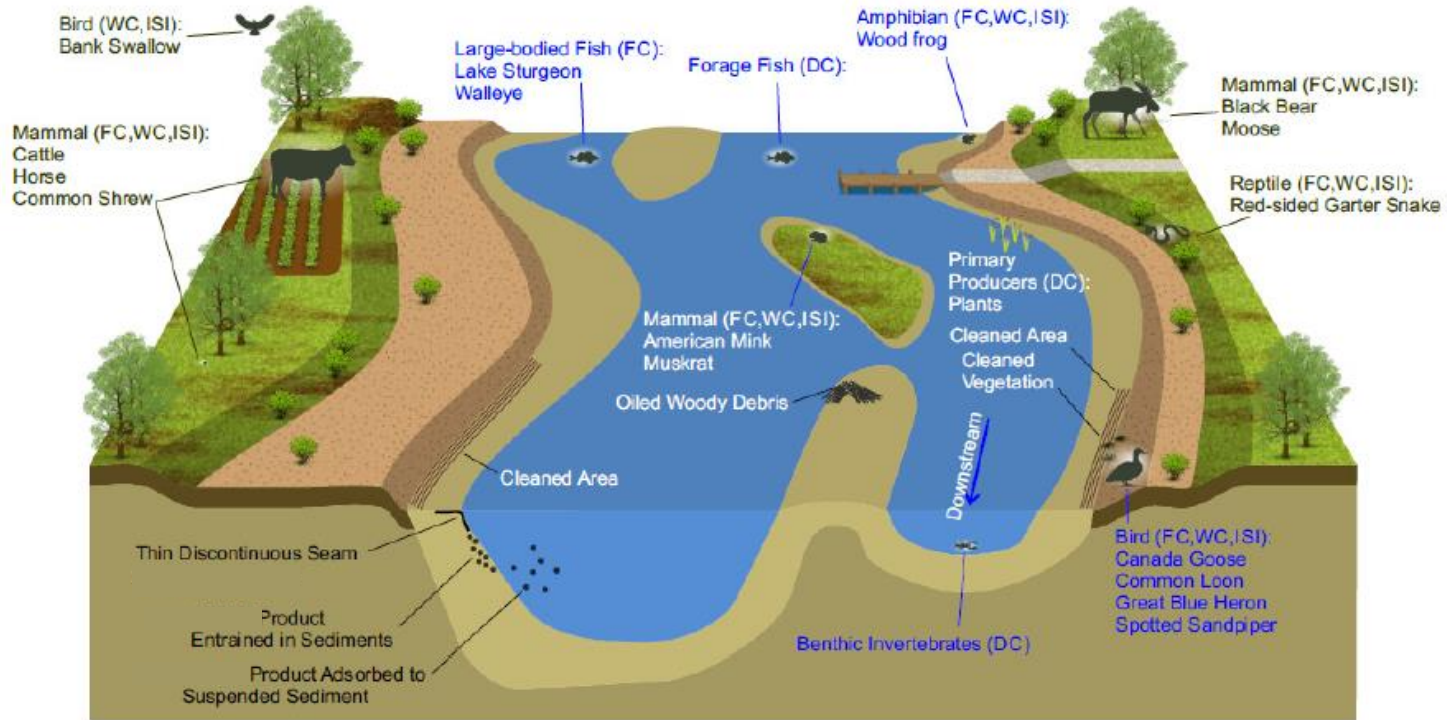
Human Health Risk Assessment



The risk from residual product was found to be acceptably low for human receptors

Ecological Risk Assessment

Exposure risk found in very localized areas associated with the No Further Treatment sites for some ecological receptors.



Pathways: DC- Direct Contact (sediment and/or pore water), FC- Food Consumption (for piscivorous and benthivorous species only), WC- Water Consumption (pore water), ISI- Incidental Sediment Ingestion

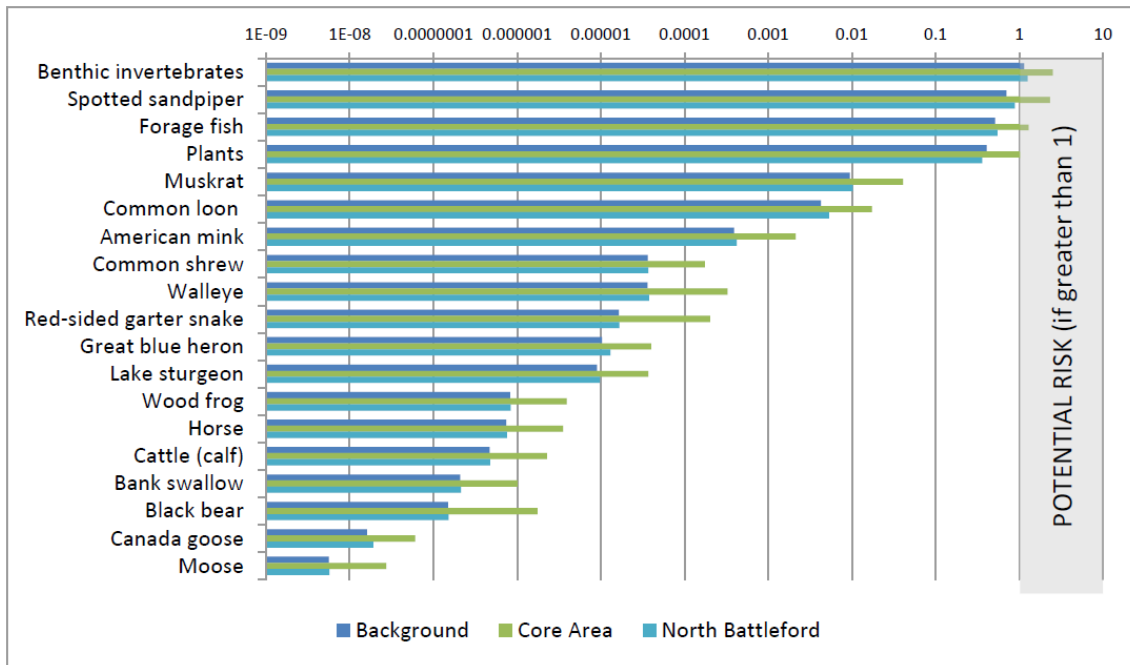
Environmental Protection Plan

- **Surface Water Trigger:**

- A surface water sample exceeds water quality criteria and fingerprinting indicates a released source

- **Sediment Trigger:**

- A sediment sample exceeds sediment probable effects level (PEL) quality criteria and fingerprinting indicates a released oil source



Tier 3 Closure Report

Report forms the the basis of a Notice of Site Condition (NoSC) registration request, to provide remedial regulatory closure

1

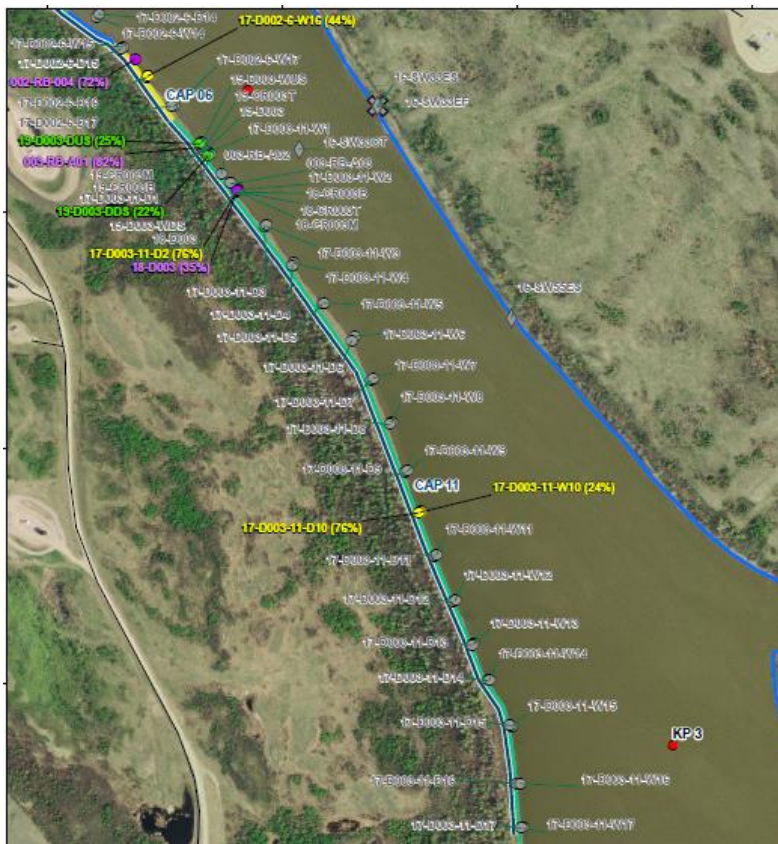
Evaluate the residual oiling status and associated risk of impacted areas (CAPs)

2

Evaluate overall treatment status of entire study area to determine if remediation efforts have resulted in a level of acceptable residual risk

Tier 3 Closure Report – Objective 1

Corrective Action Plan Report Example



2017 Results Based Objectives	Area of 2017 CAP	CAP Current Status	Saskatchewan Environment Qualified Person
Less than 10% oil distribution, non-sticky residue that is 0.1 cm or less in thickness on surface sediments. No brown or liquid oil in subsurface sediments.	1,000 m x 2 m	No Further Treatment – Net Environmental Benefit	E.H. Owens (signed off May 31, 2017)

Table A CAP 6 Oiling Summary

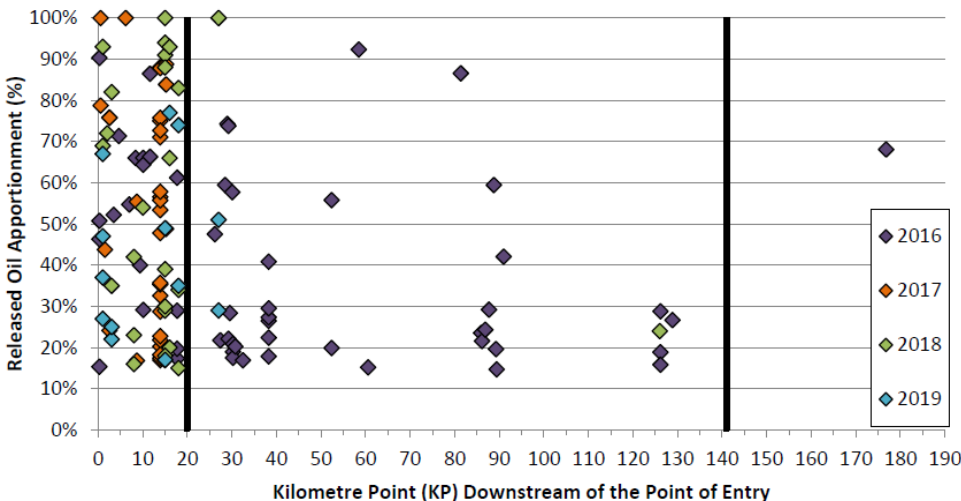
2016-2017 Remediation						
Date	26-Jul-2016	10-Aug-2016	23-Sep-2016	12-May-2017	11-Jul-2017	24-Aug-2017
Oiling Category	Heavy	Moderate	Trace	Moderate	Very Light	Very Light
Treatment	Ongoing	Ongoing	Ongoing	CAP 6 Created	Ongoing	Completed (NFT)

2018-2019 Post-remediation Monitoring				
Date	5-Jun-2018	20-Aug-2018	27-Sep-2019	
Surface Oiling	silver sheen and particulate oil halos (discrete locations)	oiled debris balls/patties; surface oiling residue	no observed oiling	
Subsurface Oiling	No. of Pits Dug	16	26	31
	No Observed Oiling	6	7	24
	Silver Sheen Observed	3	12	5
	Rainbow Sheen Observed	2	6	2
	Brown Sheen Observed	5	1	0

Closure Site Conditions	
<ul style="list-style-type: none"> Remedial activities in 2016 and 2017 removed as much oiling as practical without causing extensive shoreline erosion. Residual oiling observed was removed where possible in 2018 and 2019. Two years of follow up surveys in 2018 and 2019 showed no visible adverse effects from the remaining residual oiling and a reducing trend indicating natural attenuation is occurring and the segment has approached RBOs. Natural attenuation is the recommended continued treatment method for the remaining residual subsurface oil due to net environmental benefit. No further remediation or assessment required as control has been maintained. 	

Tier 3 Closure Report

Objective 2 Residual Distribution



- Residual product in sediment
 - Core Area (20 km from spill)
 - Rainbow/silver sheen on the sediment surface when disturbed
 - Small organic debris balls/patties
 - As a thin (<2 cm) discontinuous lens in upper 15 cm sediment layer
 - Downstream of Core Area (20 km from spill):
 - small, discontinuous oil staining on woody debris.
- No residual product in surface water after 2017

Tier 3 Closure Report

Objective 2: Residual Risk Validation

- Control maintained at Shoreline CAPs
 - Conditions improving due to attenuation
- Surface water and sediment quality
 - Unchanged or improving
- Residual risk
 - Improving for ecological receptors
 - Unchanged for human health receptors

Trophic Level and Most Exposed Population	2018 Hazard Indices			2019 Hazard Indices		
	Background	Core Area Division		Background	Core Area Division	
		████████ Sourced	Total		████████ Sourced	Total
Results using 95th Percentile Concentrations						
Plants (primary producers)	0.41	0.62	1.03	0.49	0.11	0.51
Benthic invertebrates	1.14	1.42	2.54	1.37	0.21	1.42
Forage fish	0.51	0.80	1.30	0.61	0.11	0.65
Aquatic wildlife (spotted sandpiper)	0.70	1.64	2.34	0.83	0.42	1.25
Results using Median Concentrations						
Plants (primary producers)	0.192	0.125	0.240	0.246	0.183	0.334
Benthic invertebrates	0.336	0.405	0.548	0.419	0.584	0.866
Forage fish	0.151	0.178	0.237	0.188	0.270	0.388
Aquatic wildlife (spotted sandpiper)	0.258	0.256	0.263	0.319	0.321	0.336

Note: Hazard Indices using median concentrations are similar for Background, ██████████ Sourced, and Total Hazard Indices due to the majority of source PAH data being below the analytical detection limit.

Tier 3 Closure Report

Conclusions

Evaluate the residual oiling status and associated risk of impacted areas (CAPs)

- Shoreline cleanup: Control maintained
- Surface water: residual product not detected
- Sediment: localized concentrations of product found to be decreasing

Evaluate overall treatment status of entire study area to determine if remediation efforts have resulted in a level of acceptable residual risk

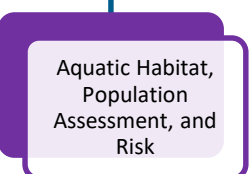
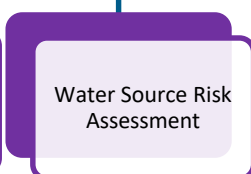
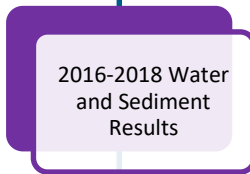
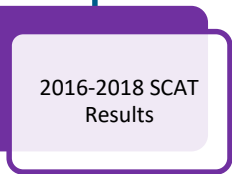
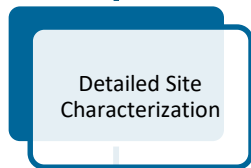
- EPP: No trigger conditions were identified in 2019
- Residual Risk: Acceptable overall (decreasing hazard indices)

Conclusion

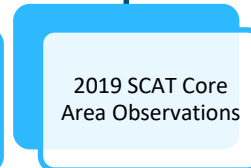
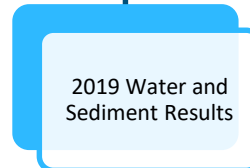
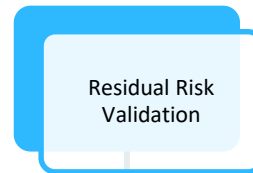
- No further monitoring was recommended beyond 2019
- A Notice of Site Condition registration is considered appropriate

Closure Process

3. Environmental Protection Plan (2018-2019)



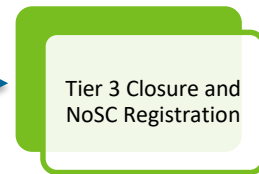
1. Oil Characterization and Delineation (2016-2017)
2. Fate & Transport (2016-2018)




4. Residual Risk Validation (2019)



5. Closure (2020-Present)





Tara Murfitt, P.Geo.
Senior Hydrogeologist
403-727-0634

tmurfitt@matrix-solutions.com

Shaun Toner, P.Biol., PMP
Senior Environmental Scientist
226-341-1933

stoner@matrix-solutions.com