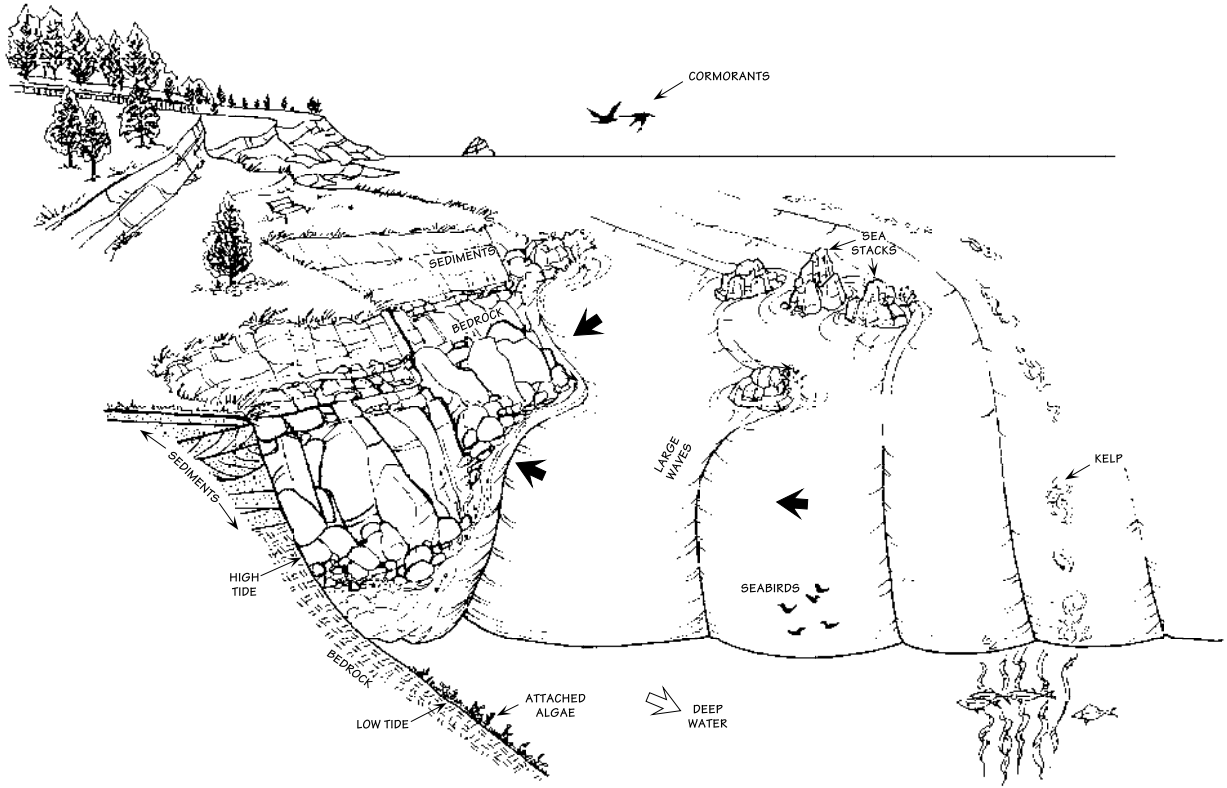
INTERTIDAL: Exposed Rocky Shores



Description

- The intertidal zone is steep (>30° slope) and narrow with very little width.
- Sediment accumulations are uncommon because waves remove debris that has slumped from the eroding cliffs.
- There is strong vertical zonation of intertidal biological communities.
- Species density and diversity vary greatly, but barnacles, snails, mussels, polychaetes, and macroalgae can be abundant.

Predicted Oil Behavior

- Oil is held offshore by waves reflecting off the steep, hard surfaces.
- Any oil that is deposited is rapidly removed from exposed faces.
- The most resistant oil would remain as a patchy band at or above the high-tide line.
- Impacts to intertidal communities are expected to be short-term. An exception would be where heavy concentrations of a light refined product came ashore very quickly.

Response Considerations

- Cleanup is usually not required.
- Access can be difficult and dangerous.

INTERTIDAL: Exposed Rocky Shores

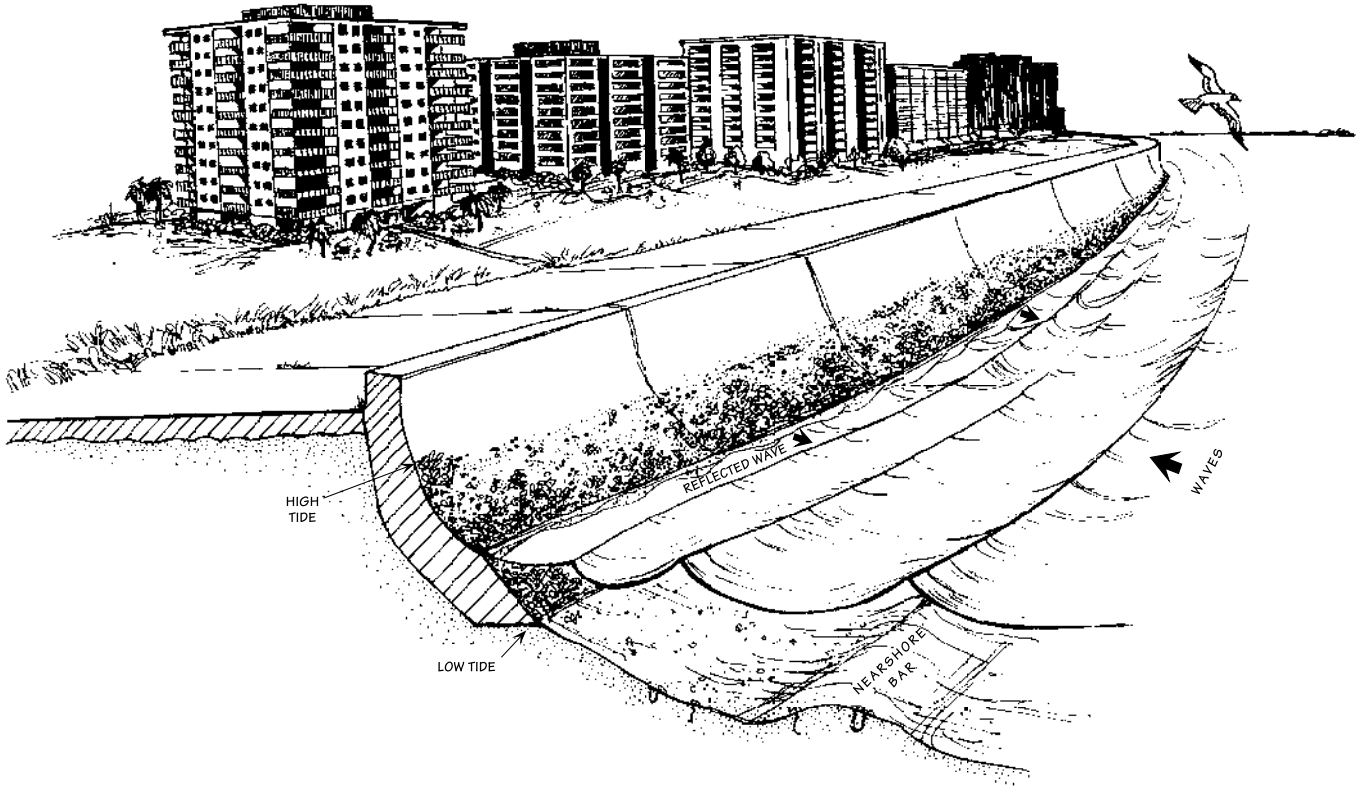
Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

A = The least adverse habitat impact.
B = Some adverse habitat impact.
C = Significant adverse habitat impact.
D = The most adverse habitat impact.
I = Insufficient information - impact or effectiveness of the method could not be evaluated.
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	A	A	A
Barriers/Berms	–	–	–	–	–
Manual Oil Removal/Cleaning	–	–	B	B	B
Mechanical Oil Removal	–	–	–	–	–
Sorbents	–	B	A	A	A
Vacuum	–	A	A	A	A
Debris Removal	–	A	A	A	A
Sediment Reworking/Tilling	–	–	–	–	–
Vegetation Cutting/Removal	–	–	C	C	C
Flooding (deluge)	–	–	–	–	–
Low-pressure, Ambient Water Flushing	–	A	A	B	B
High-pressure, Ambient Water Flushing	–	B	B	B	B
Low-pressure, Hot Water Flushing	–	–	C	C	C
High-pressure, Hot Water Flushing	–	–	C	C	C
Steam Cleaning	–	–	D	D	–
Sand Blasting	–	–	D	D	D
Solidifiers	–	–	–	–	–
Shoreline Cleaning Agents	–	–	C	C	C
Nutrient Enrichment	–	–	–	–	–
Natural Microbe Seeding	–	–	–	–	–
In-situ Burning	–	–	–	–	–


HIGH
TIDE
REFLECTED WAVE
WAVES
LOW TIDE
NEARSHORE
BAR

INTERTIDAL: Exposed, Solid Man-made Structures

Description

- These are solid, man-made structures such as seawalls, groins, revetments, piers, and port facilities.
- Many structures are constructed of concrete, wood, or metal.
- They are built to protect the shore from erosion by waves, boat wakes, and currents, and thus are exposed to rapid natural removal processes.
- Often there is no exposed substrate at low tide, but multiple habitats may be present.
- Attached animals and plants are sparse to common.

Predicted Oil Behavior

- Oil is held offshore by waves reflecting off the steep, hard surfaces in exposed settings.
- Oil readily adheres to the dry, rough surfaces, but it does not adhere to wet substrates.
- The most resistant oil would remain as a patchy band at or above the high-tide line.

Response Considerations

- Cleanup is usually not required.
- High-pressure water spraying may be conducted to remove risks of contamination of people or vessels or to improve aesthetics.

Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in this table mean:

A = The least adverse habitat impact.
B = Some adverse habitat impact.
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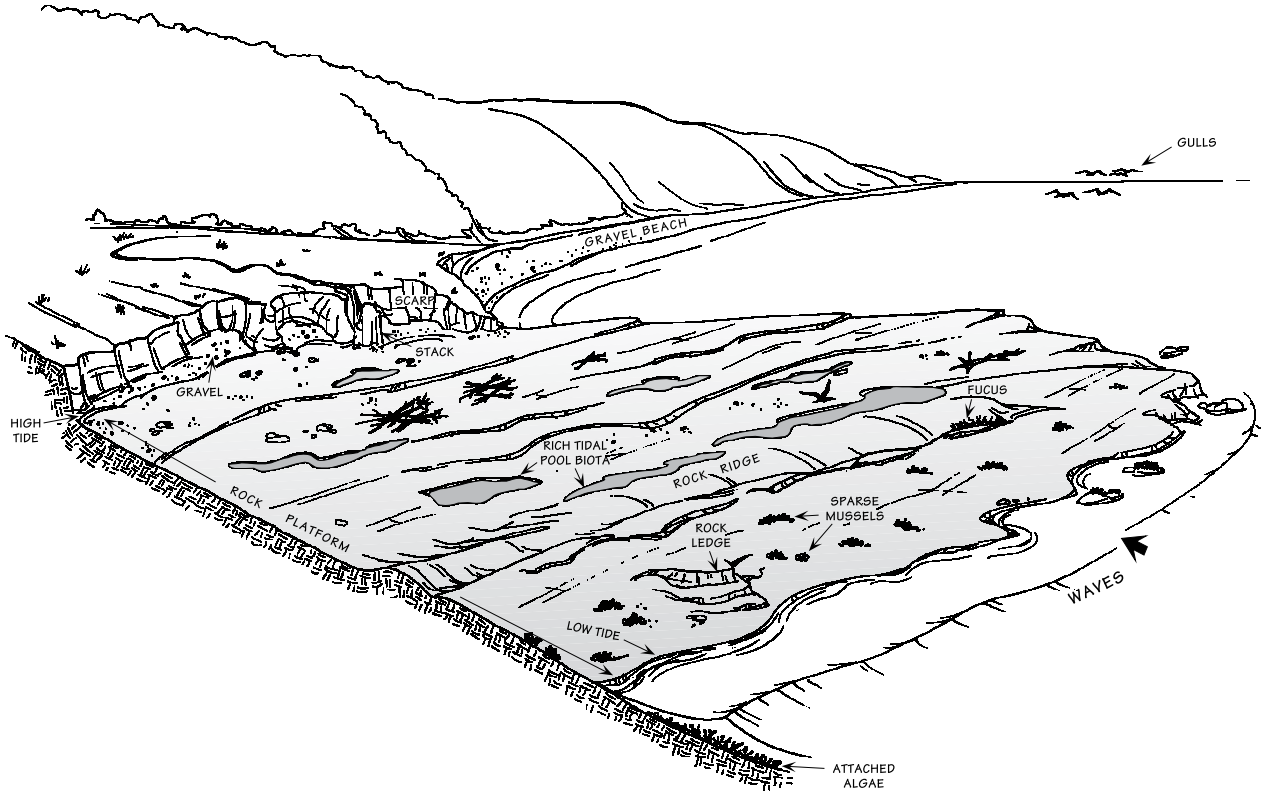
I = Insufficient information - impact or effectiveness of the method could not be evaluated.
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	A	A	A
Barriers/Berms	–	–	–	–	–
Manual Oil Removal/Cleaning	–	–	B	B	B
Mechanical Oil Removal	–	–	–	–	–
Sorbents	–	B	A	A	A
Vacuum	–	–	–	–	–
Debris Removal	–	–	–	–	–
Sediment Reworking/Tilling	–	–	–	–	–
Vegetation Cutting/Removal	–	–	B	B	B
Flooding (deluge)	–	–	–	–	–
Low-pressure, Ambient Water Flushing	–	A	A	B	B
High-pressure, Ambient Water Flushing	–	B	B	B	B
Low-pressure, Hot Water Flushing	–	–	C	C	C
High-pressure, Hot Water Flushing	–	–	C	C	C
Steam Cleaning	–	–	D	D	D
Sand Blasting	–	–	D	D	D
Solidifiers	–	–	–	–	–
Shoreline Cleaning Agents	–	–	B	B	B
Nutrient Enrichment	–	–	–	–	–
Natural Microbe Seeding	–	–	–	–	–
In-situ Burning	–	–	–	–	–

INTERTIDAL: Exposed, Wave-cut Platforms



Description

- These shores consist of a bedrock shelf or platform of variable width and very gentle slope.
- The surface of the platform is irregular; tide pools are common.
- Along headlands, they have only small accumulation of sediments, mostly at the high-tide line.
- They often co-occur with gravel beaches; the gravel beach can be either at the upper or the lower half of the intertidal zone, depending on the nature of the bedrock outcrop.
- Species density and diversity vary greatly, but barnacles, snails, mussels, and macroalgae are often abundant.

Predicted Oil Behavior

- Oil will not adhere to the wet rock surface, but could penetrate crevices or sediment veneers.
- Oil persistence is usually short-term, except in wave shadows or where the oil was deposited high above normal wave activity.

Response Considerations

- Cleanup is usually not required.
- Where the high-tide area is accessible, it may be feasible to manually remove heavy oil accumulations and oiled debris.

INTERTIDAL: Exposed, Wave-cut Platforms

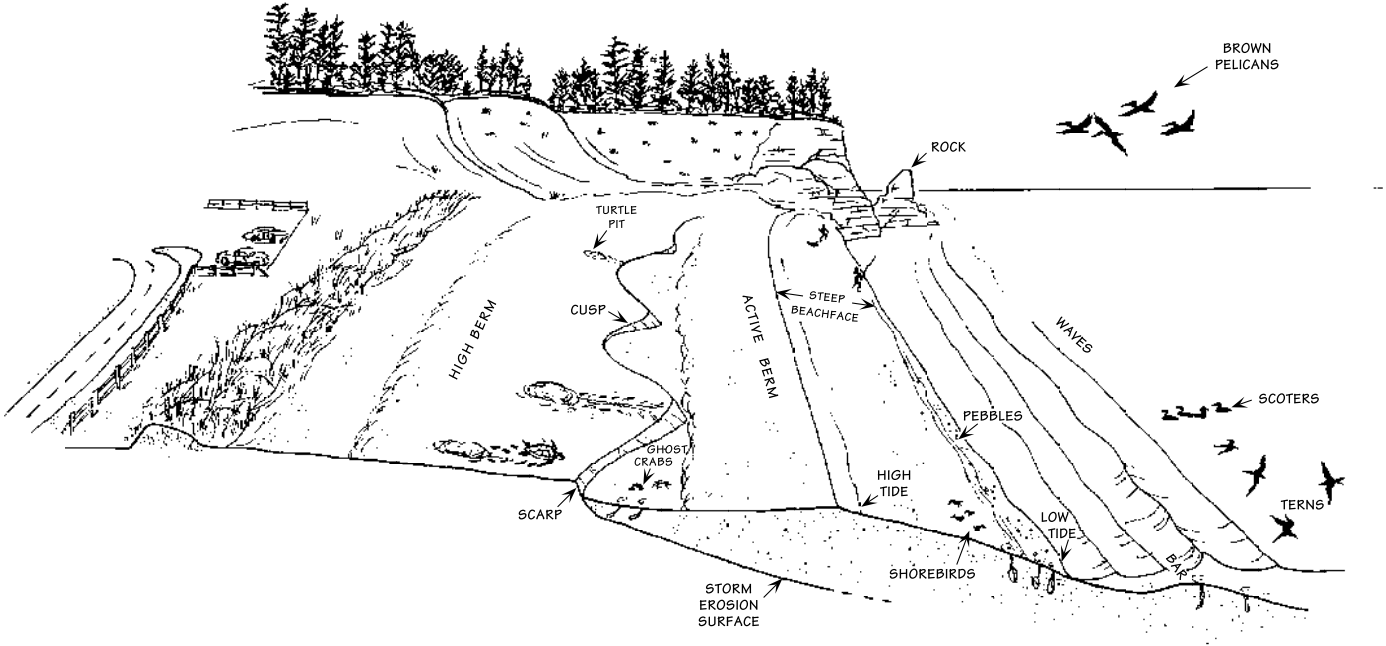
Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

A = The least adverse habitat impact.
B = Some adverse habitat impact.
C = Significant adverse habitat impact.
D = The most adverse habitat impact.
I = Insufficient information - impact or effectiveness of the method could not be evaluated.
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	A	A	A
Barriers/Berms	–	–	–	–	–
Manual Oil Removal/Cleaning	–	B	B	B	B
Mechanical Oil Removal	–	–	–	–	–
Sorbents	–	B	A	A	A
Vacuum	–	A	A	A	A
Debris Removal	–	A	A	A	A
Sediment Reworking/Tilling	–	–	–	–	–
Vegetation Cutting/Removal	–	–	C	C	C
Flooding (deluge)	–	A	A	B	B
Low-pressure, Ambient Water Flushing	–	A	A	B	B
High-pressure, Ambient Water Flushing	–	B	B	B	B
Low-pressure, Hot Water Flushing	–	D	C	C	C
High-pressure, Hot Water Flushing	–	D	C	C	C
Steam Cleaning	–	–	D	D	D
Sand Blasting	–	–	D	D	D
Solidifiers	–	C	C	–	–
Shoreline Cleaning Agents	–	–	C	C	C
Nutrient Enrichment	–	–	–	–	–
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	D	D	D	–


BROWN PELICANS
ROCK
TURTLE PIT
CUSP
HIGH BERM
ACTIVE BERM
STEEP BEACHFACE
WAVES
SCOTERS
PEBBLES
GHOST CRABS
HIGH TIDE
TERNS
SCARP
LOW TIDE
BAR
SHOREBIRDS
STORM EROSION SURFACE

INTERTIDAL: Sand Beaches

Description

- These beaches are flat to moderately sloping and relatively hard-packed.
- There can be heavy accumulations of wrack.
- They can be important areas for nesting by birds and turtles.
- Upper beach fauna include ghost crabs and amphipods; lower beach fauna can be moderate, but highly variable.

Predicted Oil Behavior

- Light oil accumulations will be deposited as oily swashes or bands along the upper intertidal zone.
- Heavy oil accumulations will cover the entire beach surface; oil will be lifted off the lower beach with the rising tide.
- Maximum penetration of oil into fine- to medium-grained sand is about 10-15 cm, up to 25 cm in coarse-grained sand.
- Burial of oiled layers by clean sand can be rapid (within one day), and burial to depths as much as one meter is possible if the oil comes ashore at the beginning of a depositional period.
- Organisms living in the beach sediment may be killed by smothering or lethal oil concentrations in the interstitial water.
- Biological impacts include temporary declines in infauna, which can affect important shorebird foraging areas.

Response Considerations

- These beaches are among the easiest shoreline types to clean.
- Cleanup should concentrate on removing oil and oily debris from the upper swash zone once most of the oil has come ashore.
- Manual cleanup, rather than road graders and front-end loaders, is advised to minimize volume of sand removed from the shore and requiring disposal.
- All efforts should focus on preventing vehicular and foot traffic from mixing oil deeper into the sediments.
- Mechanical reworking of lightly oiled sediments from the high-tide line to the middle intertidal zone can be effective along exposed beaches.

Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

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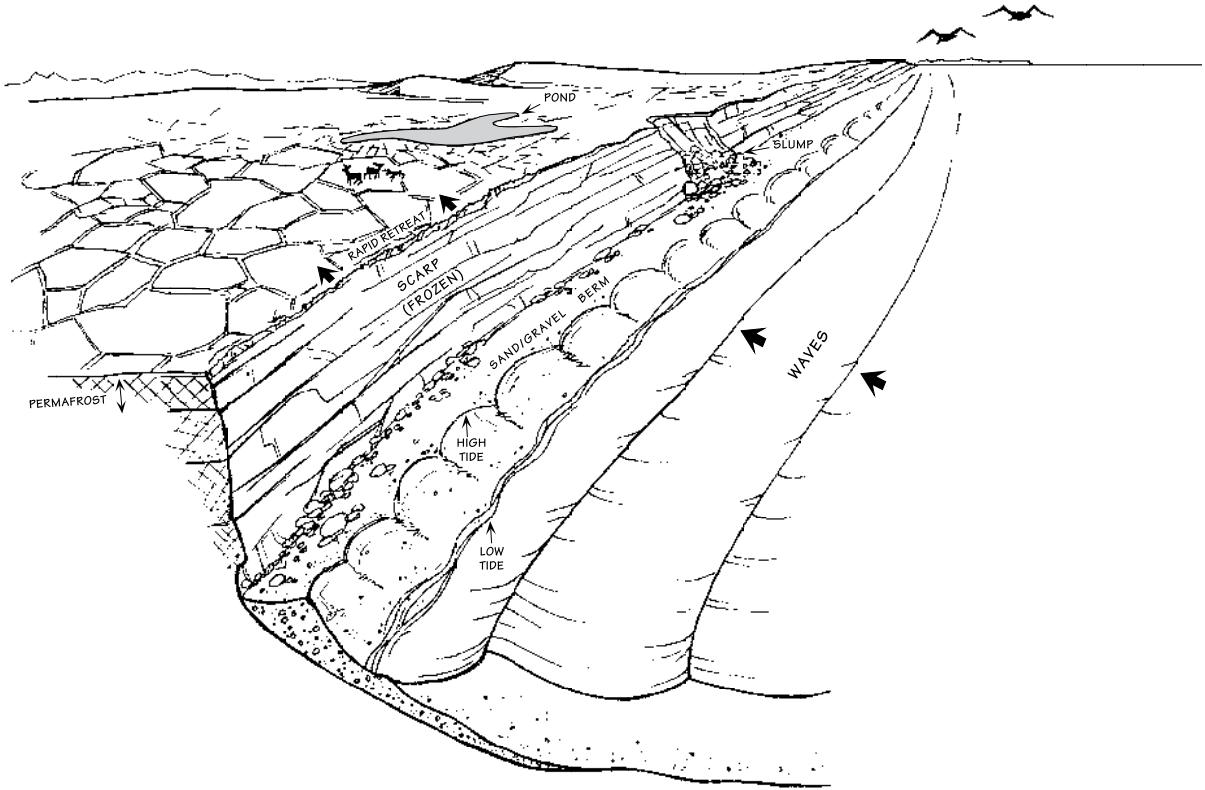
	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	B	B	C	C
Barriers/Berms	B	B	B	B	B
Manual Oil Removal/Cleaning	D	B	A	A	A
Mechanical Oil Removal	D	B	B	B	B
Sorbents	–	B	A	A	B
Vacuum	–	–	B	A	A
Debris Removal	–	A	A	A	–
Sediment Reworking/Tilling	D	B	B	B	B
Vegetation Cutting/Removal	–	C	C	C	C
Flooding (deluge)	A	A	A	B	C
Low-pressure, Ambient Water Flushing	B	B	B	B	C
High-pressure, Ambient Water Flushing	–	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	C	C	C
High-pressure, Hot Water Flushing	–	–	–	–	–
Steam Cleaning	–	–	–	–	–
Sand Blasting	–	–	–	–	–
Solidifiers	–	–	B	–	–
Shoreline Cleaning Agents	–	–	C	C	C
Nutrient Enrichment	–	A	A	B	B
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	–	C	C	C

INTERTIDAL: Tundra Cliffs



Description

- These are erosional features with tundra vegetation overlying peat and exposed ground ice or permafrost.
- Cliff heights range from less than 1 meter to as much as 5-10 meters.
- There may be a narrow beach present or just a vertical scarp.
- As the cliffs erode at rates of 0.5-4 meters/year, the vegetation and peat accumulate as fragmented and irregular blocks at the base of the cliff until they are reworked by waves.
- The vegetation on the tundra is a living plant community that is sensitive to disturbances.
- Large numbers of migratory birds can use these shorelines during the summer months.

Predicted Oil Behavior

- Oil could be stranded onshore only during the ice-free summer season.
- Oil is not likely to adhere to exposed ground ice, unless air temperatures are below freezing.
- Oil persistence on the vegetation and peat substrates would be short in most cases, due to natural cliff erosion, provided that the oil is not stranded at the onset of freeze-up.
- If the oil mixes with the peaty substrate or accumulated peat, it could create sheens until the oiled area erodes.
- Biological risks would be greatest to birds feeding along oiled cliffs in summer.

Response Considerations

- Natural peat can be used as a sorbent as long as it is taken from beach peat deposits and not the living tundra.
- Manual or mechanical removal of oil or oiled tundra/peat may be the most practical method if oil removal is required, though the peat substrate is soft and readily trampled.
- Hot-water washing or even low-pressure flushing is not appropriate because they may accelerate thermal and mechanical erosion of the ice in the cliff, triggering unexpected block falls, slumping, or mud flows.
- The cliffs are commonly undercut and naturally unstable, so worker safety is a primary concern.
- Cleanup occurs only in the short arctic summer, a very limited window of intense ecological activity.

INTERTIDAL: Tundra Cliffs

Oil Category Descriptions

I – Gasoline products
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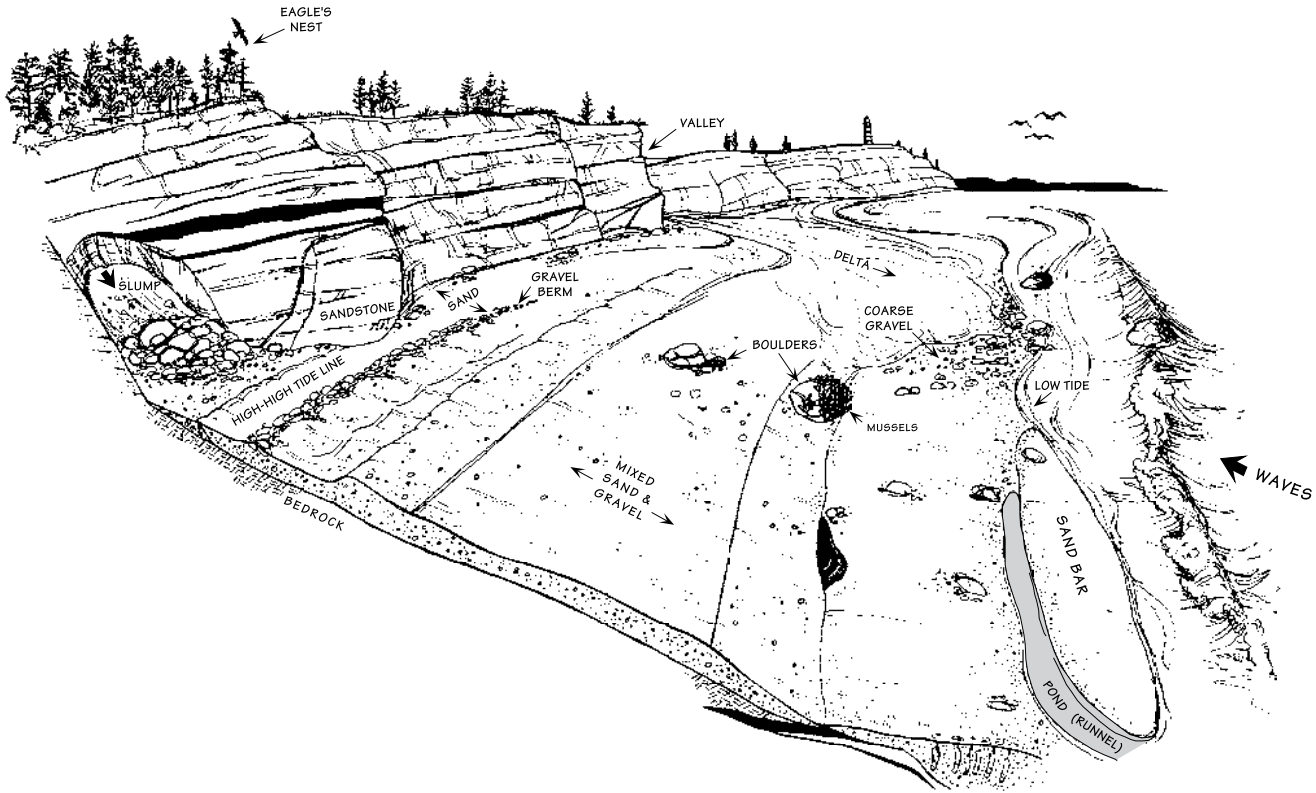
	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	B	B	B	B
Barriers/Berms	B	B	B	B	B
Manual Oil Removal/Cleaning	D	B	B	B	B
Mechanical Oil Removal	C	C	C	C	C
Sorbents	–	B	A	A	B
Vacuum	–	–	B	A	A
Debris Removal	–	B	B	B	B
Sediment Reworking/Tilling	D	B	B	B	C
Vegetation Cutting/Removal	D	D	D	D	D
Flooding (deluge)	A	A	A	B	C
Low-pressure, Ambient Water Flushing	C	B	B	B	–
High-pressure, Ambient Water Flushing	–	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–	–
Steam Cleaning	–	–	–	–	–
Sand Blasting	–	–	–	–	–
Solidifiers	–	–	B	–	–
Shoreline Cleaning Agents	–	–	–	–	–
Nutrient Enrichment	–	B	B	C	C
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	–	–	–	–


EAGLE'S NEST
VALLEY
SLUMP
SANDSTONE
SAND
GRAVEL BERM
DELTA
COARSE GRAVEL
BOULDERS
LOW TIDE
MUSSELS
HIGH-HIGH TIDE LINE
MIXED SAND & GRAVEL
BEDROCK
SAND BAR
POND (RUNNEL)
WAVES

INTERTIDAL: Sand and Gravel Beaches

Description

- Because of the mixed sediment sizes on these moderately sloping beaches, there may be zones of pure sand, pebbles, or cobbles.
- There can be large-scale changes in the sediment distribution patterns depending upon season, because of the transport of the sand fraction offshore during storms.
- Desiccation and sediment mobility on exposed beaches cause low densities of attached animals and plants.
- The presence of attached algae, mussels, and barnacles indicates beaches that are relatively sheltered, with the more stable substrate supporting a richer biota.

Predicted Oil Behavior

- During small spills, oil will be deposited along and above the high-tide swash.
- Large spills will spread across the entire intertidal area.
- Oil penetration into the beach sediments may be up to 50 cm; however, the sand fraction can be quite mobile, and oil behavior is much like on a sand beach if the sand fraction exceeds about 40 percent.
- Burial of oil may be deep at and above the high-tide line, where oil tends to persist, particularly where beaches are only intermittently exposed to waves.
- In sheltered pockets on the beach, pavements of asphalted sediments can form if oil accumulations are not removed, because most of the oil remains on the surface.

Response Considerations

- Remove heavy accumulations of pooled oil from the upper beachface.
- All oiled debris should be removed; sediment removal should be limited as much as possible.
- Low-pressure flushing can be used to float oil away from the sediments for recovery by skimmers or sorbents. High-pressure spraying should be avoided because of potential for transporting contaminated finer sediments (sand) to the lower intertidal or subtidal zones.
- Mechanical reworking of oiled sediments from the high-tide zone to the middle intertidal zone can be effective in areas regularly exposed to wave activity. However, oiled sediments should not be relocated below the mid-tide zone.
- In-place tilling may be used to reach deeply buried oil layers in the mid-tide zone on exposed beaches.

Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

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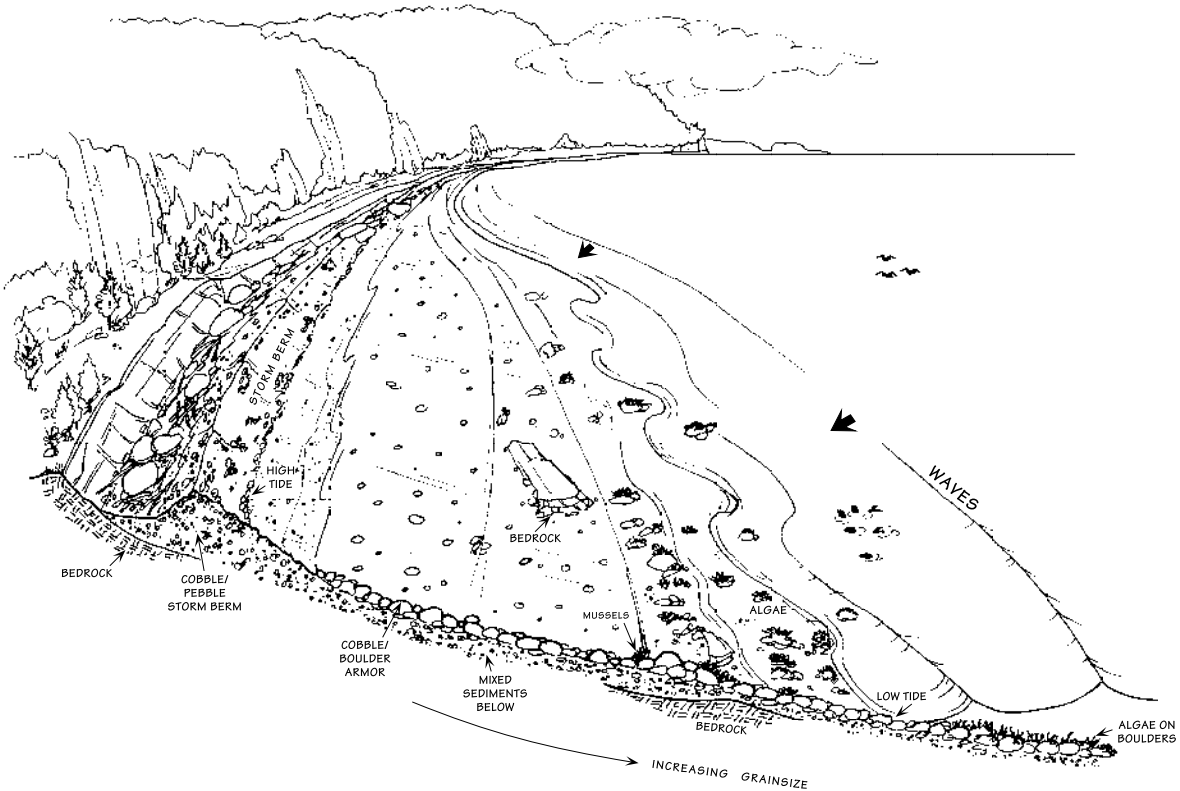
	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	B	B	C	C
Barriers/Berms	C	C	C	B	B
Manual Oil Removal/Cleaning	D	C	B	B	B
Mechanical Oil Removal	D	C	B	B	B
Sorbents	–	A	A	B	B
Vacuum	–	–	B	B	B
Debris Removal	–	A	A	A	A
Sediment Reworking/Tilling	D	B	B	B	B
Vegetation Cutting/Removal	–	C	C	C	C
Flooding (deluge)	A	A	B	C	C
Low-pressure, Ambient Water Flushing	B	A	A	B	C
High-pressure, Ambient Water Flushing	–	–	C	D	D
Low-pressure, Hot Water Flushing	–	–	C	C	C
High-pressure, Hot Water Flushing	–	–	D	D	D
Steam Cleaning	–	–	D	D	D
Sand Blasting	–	–	–	–	–
Solidifiers	–	–	B	–	–
Shoreline Cleaning Agents	–	–	C	C	C
Nutrient Enrichment	–	A	A	B	C
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	–	C	C	C

INTERTIDAL: Gravel Beaches



Description

- Gravel beaches can be very steep, with multiple wave-built berms forming the upper beach.
- The degree of exposure to wave energy can be highly variable among gravel beaches.
- Density of animals and plants in the upper intertidal zone is low on exposed beaches, but can be high on sheltered gravel beaches and on the lower intertidal zone of all beaches.

Predicted Oil Behavior

- Stranded oil is likely to penetrate deeply into gravel beaches because of their high permeability.
- Rapid burial can occur at the high-tide and storm berms.
- Long-term persistence will be controlled by the depth of routine reworking by the waves.
- On exposed beaches, oil can be pushed over the high-tide berms, pooling and persisting above the normal influence of wave washing.
- Along sheltered portions of the shorelines, chronic sheening and the formation of asphalt pavements is likely where accumulations are heavy.

Response Considerations

- Heavy accumulations of pooled oil should be removed quickly from the upper beach.
- All oiled debris should be removed.
- Sediment removal should be limited as much as possible.
- Low- to high-pressure flushing can be effective if all released oil is recovered with skimmers or sorbents.
- Mechanical reworking of oiled sediments from the high-tide line to the mid beachface can be effective in areas regularly exposed to wave activity; the presence of multiple storm berms is evidence of wave activity. However, oiled sediments should not be relocated below the mid-tide zone.
- In-place tilling may be used to reach deeply buried oil layers along the mid-tide zone on exposed beaches.

INTERTIDAL: Gravel Beaches

Oil Category Descriptions

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II – Diesel-like products and light crudes
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IV – Heavy crudes and residual products
V – Non-floating oil products

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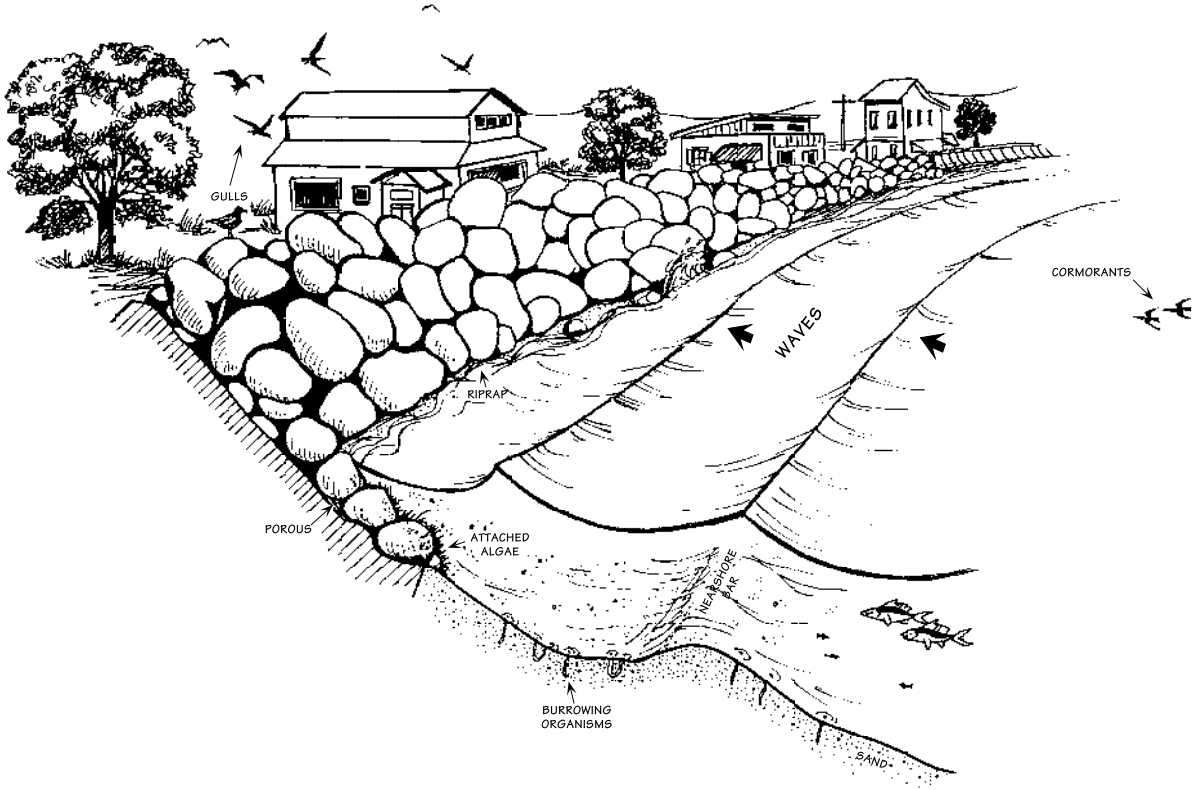
	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	B	B	B
Barriers/Berms	–	B	B	B	B
Manual Oil Removal/Cleaning	D	C	B	B	A
Mechanical Oil Removal	D	D	C	C	C
Sorbents	–	A	A	B	B
Vacuum	–	–	B	B	B
Debris Removal	–	A	A	A	A
Sediment Reworking/Tilling	D	B	B	B	B
Vegetation Cutting/Removal	–	D	C	C	–
Flooding (deluge)	A	A	B	C	C
Low-pressure, Ambient Water Flushing	A	A	A	B	C
High-pressure, Ambient Water Flushing	–	–	B	B	B
Low-pressure, Hot Water Flushing	–	–	C	B	B
High-pressure, Hot Water Flushing	–	–	C	C	C
Steam Cleaning	–	–	D	D	D
Sand Blasting	–	–	–	–	–
Solidifiers	–	–	B	–	–
Shoreline Cleaning Agents	–	–	B	B	B
Nutrient Enrichment	–	A	A	B	B
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	–	C	C	C


GULLS
CORMORANTS
WAVES
RIPRAP
POROUS
ATTACHED ALGAE
NEARSHORE BAR
BURROWING ORGANISMS
SAND

INTERTIDAL: Riprap

Description

- Riprap structures are composed of cobble- to boulder-sized blocks of granite, limestone, concrete, or other materials.
- Riprap structures are used as revetments and groins for shoreline protection, and as breakwaters and jetties around inlets and marinas.
- Attached biota are generally sparse at the upper intertidal zone, but more common in the lower intertidal zone.
- They are common in highly developed waterfront areas.

Predicted Oil Behavior

- Deep penetration of oil between the blocks is likely, with oiling of associated debris.
- Oil adheres readily to the rough surfaces of the blocks.
- Uncleaned oil and debris can cause chronic leaching until the oil hardens.

Response Considerations

- When the oil is fresh and liquid, high pressure spraying and/or water flooding may be effective if all liberated oil is recovered.
- Heavy and weathered oils are more difficult to remove, requiring manual scraping and/or high-pressure, hot-water flushing.
- Removal of oiled debris deep in the crevices will be difficult.

Oil Category Descriptions

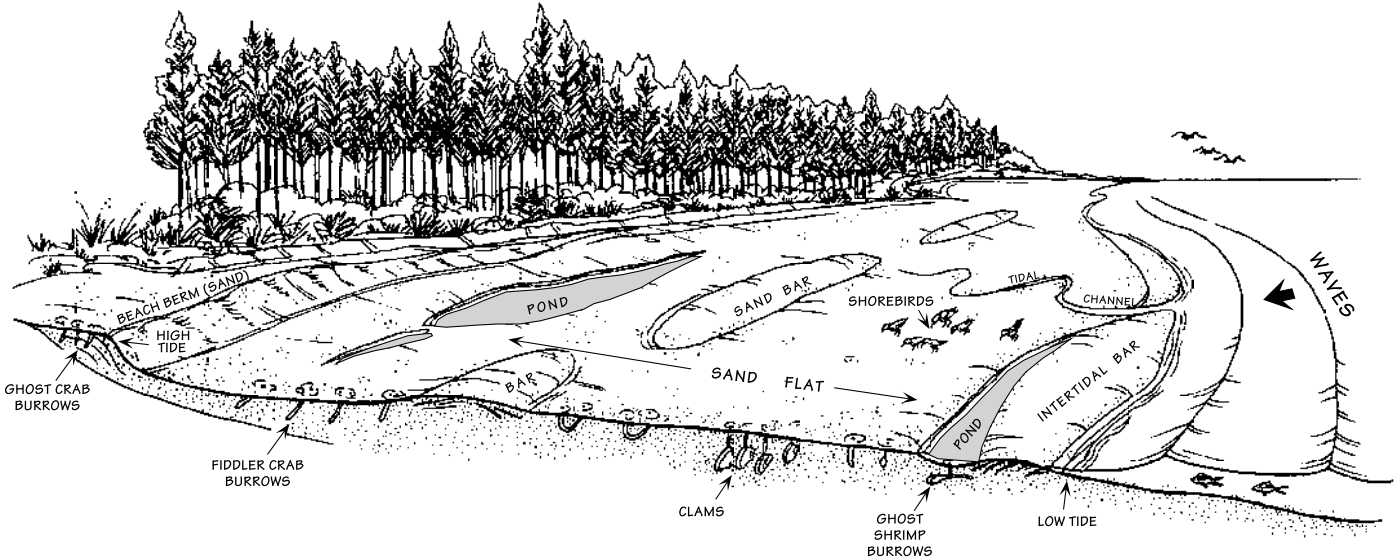
I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

A = The least adverse habitat impact.
B = Some adverse habitat impact.
C = Significant adverse habitat impact.
D = The most adverse habitat impact.
I = Insufficient information - impact or effectiveness of the method could not be evaluated.
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	B	B	B
Barriers/Berms	–	–	–	–	–
Manual Oil Removal/Cleaning	–	A	A	A	A
Mechanical Oil Removal	–	–	C	C	C
Sorbents	–	A	A	B	B
Vacuum	–	–	A	A	A
Debris Removal	–	A	A	A	A
Sediment Reworking/Tilling	–	–	–	–	–
Vegetation Cutting/Removal	–	C	C	B	B
Flooding (deluge)	A	A	B	C	C
Low-pressure, Ambient Water Flushing	A	A	B	C	C
High-pressure, Ambient Water Flushing	A	A	B	B	C
Low-pressure, Hot Water Flushing	–	C	C	C	C
High-pressure, Hot Water Flushing	–	C	C	C	C
Steam Cleaning	–	–	D	D	D
Sand Blasting	–	–	D	D	D
Solidifiers	–	B	B	–	–
Shoreline Cleaning Agents	–	–	B	B	B
Nutrient Enrichment	–	A	A	B	B
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	–	D	D	–

INTERTIDAL: Exposed Tidal Flats



Description

- Exposed tidal flats are broad intertidal areas composed primarily of sand and minor amounts of gravel or mud.
- The presence of sand indicates that tidal currents and waves are strong enough to mobilize the sediments.
- They are usually associated with another shoreline type on the landward side of the flat, though they can occur as separate shoals; they are commonly associated with tidal inlets.
- The sediments are water saturated, with only the topographically higher ridges drying out during low tide.
- Biological use can be very high, with large numbers of infauna, heavy use by birds for roosting and foraging, and use by foraging fish.

Predicted Oil Behavior

- Oil does not usually adhere to the surface of exposed tidal flats, but rather moves across the flat and accumulates at the high-tide line.
- Deposition of oil on the flat may occur on a falling tide if concentrations are heavy.
- Oil does not penetrate water-saturated sediments, but may penetrate coarse-grained sand and coat gravel.
- Biological damage may be severe, primarily to infauna, thereby reducing food sources for birds and other predators.

Response Considerations

- Currents and waves can be very effective in natural removal of the oil.
- Cleanup can be done only during low tide, thus there is a narrow window of opportunity.
- The use of heavy machinery should be restricted to prevent oil mixing into the sediments.
- Manual removal methods are preferred.

INTERTIDAL: Exposed Tidal Flats

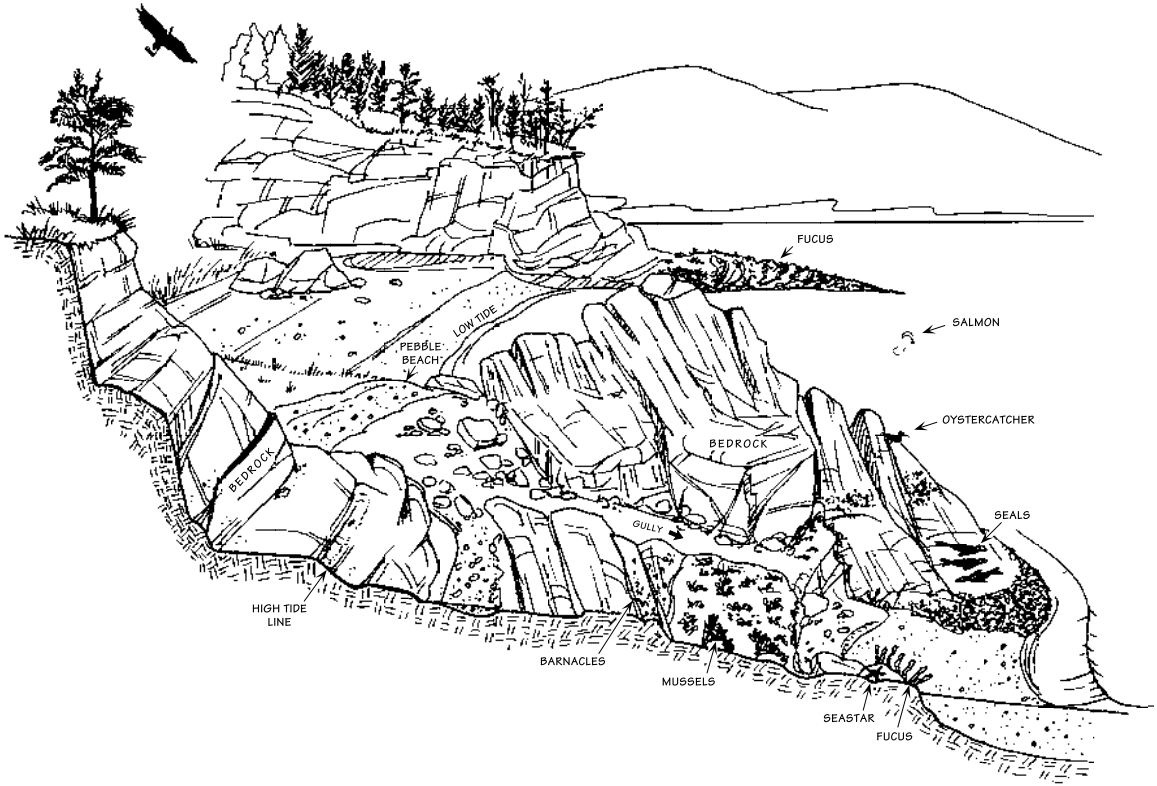
Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

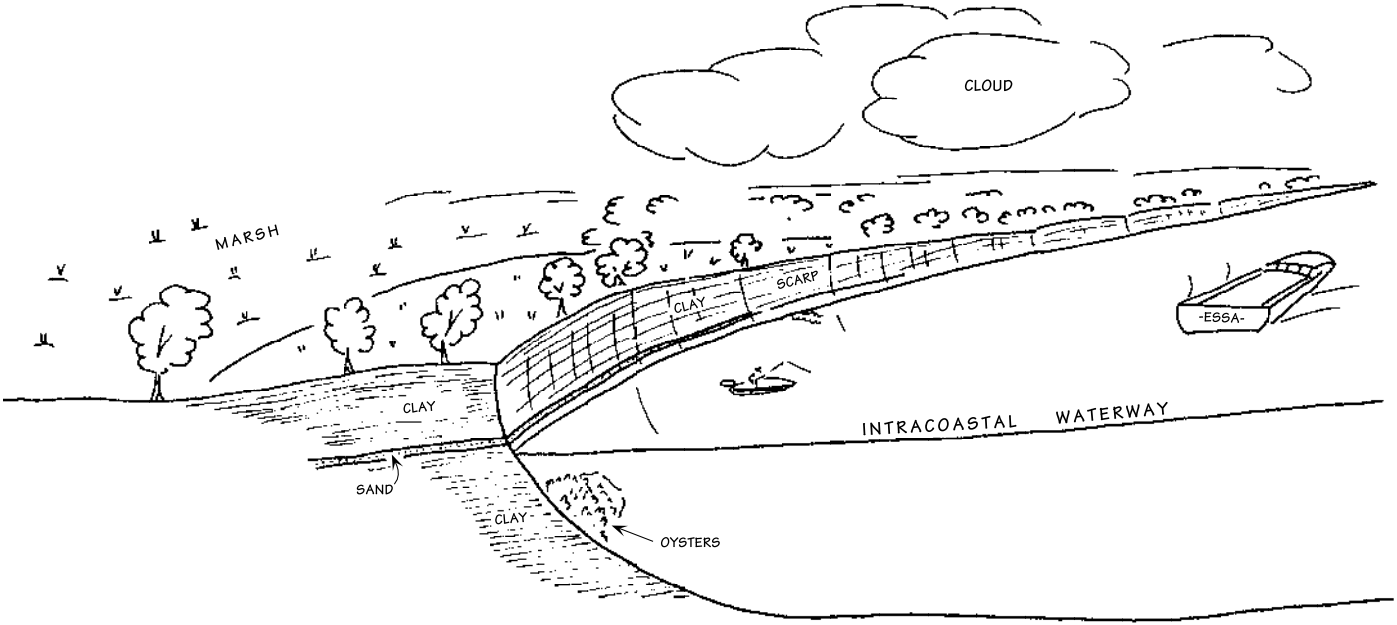
The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

A = The least adverse habitat impact.
B = Some adverse habitat impact.
C = Significant adverse habitat impact.
D = The most adverse habitat impact.
I = Insufficient information - impact or effectiveness of the method could not be evaluated.
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	A	A	A
Barriers/Berms	B	B	B	B	B
Manual Oil Removal/Cleaning	–	C	B	B	B
Mechanical Oil Removal	–	D	C	C	C
Sorbents	–	A	A	B	B
Vacuum	–	C	B	B	B
Debris Removal	–	B	B	B	B
Sediment Reworking/Tilling	–	–	C	C	C
Vegetation Cutting/Removal	–	D	D	D	D
Flooding (deluge)	–	A	A	A	B
Low-pressure, Ambient Water Flushing	–	B	B	C	C
High-pressure, Ambient Water Flushing	–	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–	–
Steam Cleaning	–	–	–	–	–
Sand Blasting	–	–	–	–	–
Solidifiers	–	C	C	–	–
Shoreline Cleaning Agents	–	–	–	–	–
Nutrient Enrichment	–	C	C	I	I
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	–	–	–	–


FUCUS
SALMON
LOW TIDE
PEBBLE BEACH
OYSTERCATCHER
BEDROCK
BEDROCK
SEALS
GULLY
HIGH TIDE LINE
BARNACLES
MUSSELS
SEASTAR
FUCUS

INTERTIDAL: Sheltered Scarps



Description

- Sheltered rocky shores are characterized by a rocky substrate that can vary widely in permeability. Of particular concern are rocky shores that have a semi-permeable veneer of angular rubble overlying the bedrock.
- Sheltered clay scarps are characterized by a steep, usually vertical scarp in hard-packed and stiff clay. Vegetation usually occurs landward of the scarp.

Predicted oil behavior

- Oil will adhere readily to dry, rough, rocky surfaces, particularly at the high-tide line, forming a distinct oil band.
- The lower intertidal zone of rocky shores is usually algae-covered and stays wet, preventing oil from adhering.
- Oil will not adhere to the wet clay sediment surface, but could penetrate dry sediment.
- Stranded oil will persist because of the low-energy setting.

Response Considerations

- Low-pressure flushing of rocky shores at ambient temperatures is most effective when the oil is fresh and still liquid.
- Extreme care must be taken during flushing operations in the upper intertidal zone to prevent oily effluents from impacting biologically rich lower tidal levels.
- Do not cut oiled, attached algae; use sorbents to recover oil as it is remobilized by tidal action.
- Where the high-water area of scarps is accessible, it might be feasible to manually remove heavy oil accumulations and oiled debris.
- The muddy substrate of scarps cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

INTERTIDAL: Sheltered Rocky Shores and Scarps

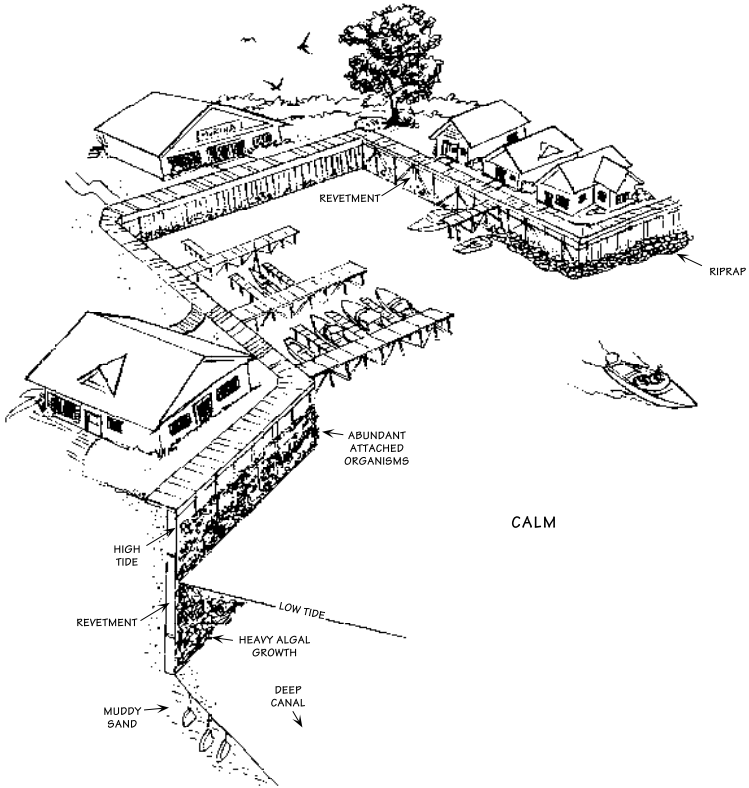
Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

A = The least adverse habitat impact.
B = Some adverse habitat impact.
C = Significant adverse habitat impact.
D = The most adverse habitat impact.
I = Insufficient information - impact or effectiveness of the method could not be evaluated.
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	B	B	B
Barriers/Berms	–	–	–	–	–
Manual Oil Removal/Cleaning	–	C	B	C	C
Mechanical Oil Removal	–	–	–	–	–
Sorbents	A	A	B	C	C
Vacuum	–	B	B	B	C
Debris Removal	–	A	A	A	A
Sediment Reworking/Tilling	–	–	–	–	–
Vegetation Cutting/Removal	–	–	D	D	D
Flooding (deluge)	–	A	A	B	C
Low-pressure, Ambient Water Flushing	–	A	A	B	C
High-pressure, Ambient Water Flushing	–	C	B	B	C
Low-pressure, Hot Water Flushing	–	–	D	D	D
High-pressure, Hot Water Flushing	–	–	D	D	D
Steam Cleaning	–	–	D	D	D
Sand Blasting	–	–	D	D	D
Solidifiers	–	C	C	–	–
Shoreline Cleaning Agents	–	–	B	B	B
Nutrient Enrichment	–	A	B	C	C
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	D	C	C	C


REVETMENT
RIPRAP
ABUNDANT ATTACHED ORGANISMS
CALM
HIGH TIDE
LOW TIDE
REVETMENT
HEAVY ALGAL GROWTH
DEEP CANAL
MUDDY SAND

INTERTIDAL: Sheltered, Solid Man-made Structures

Description

- These are structures such as seawalls, groins, revetments, piers, and port facilities, constructed of concrete, wood, or metal.
- Most structures are designed to protect a single lot, thus their composition, design, and condition are highly variable.
- Often there is no exposed beach at low tide, but multiple habitats may be present.
- There can be dense attachments of animal and plant life.
- They are common in developed waterfront areas.

Predicted Oil Behavior

- Oil will adhere readily to the rough surface, particularly along the high-tide line, forming a distinct oil band.
- The lower intertidal zone usually stays wet (particularly if algae-covered), preventing oil from adhering to the surface.

Response Considerations

- Seawalls are usually cleaned for aesthetic reasons or to prevent leaching of oil.
- Low- to high-pressure spraying at ambient water temperatures is most effective when the oil is fresh.

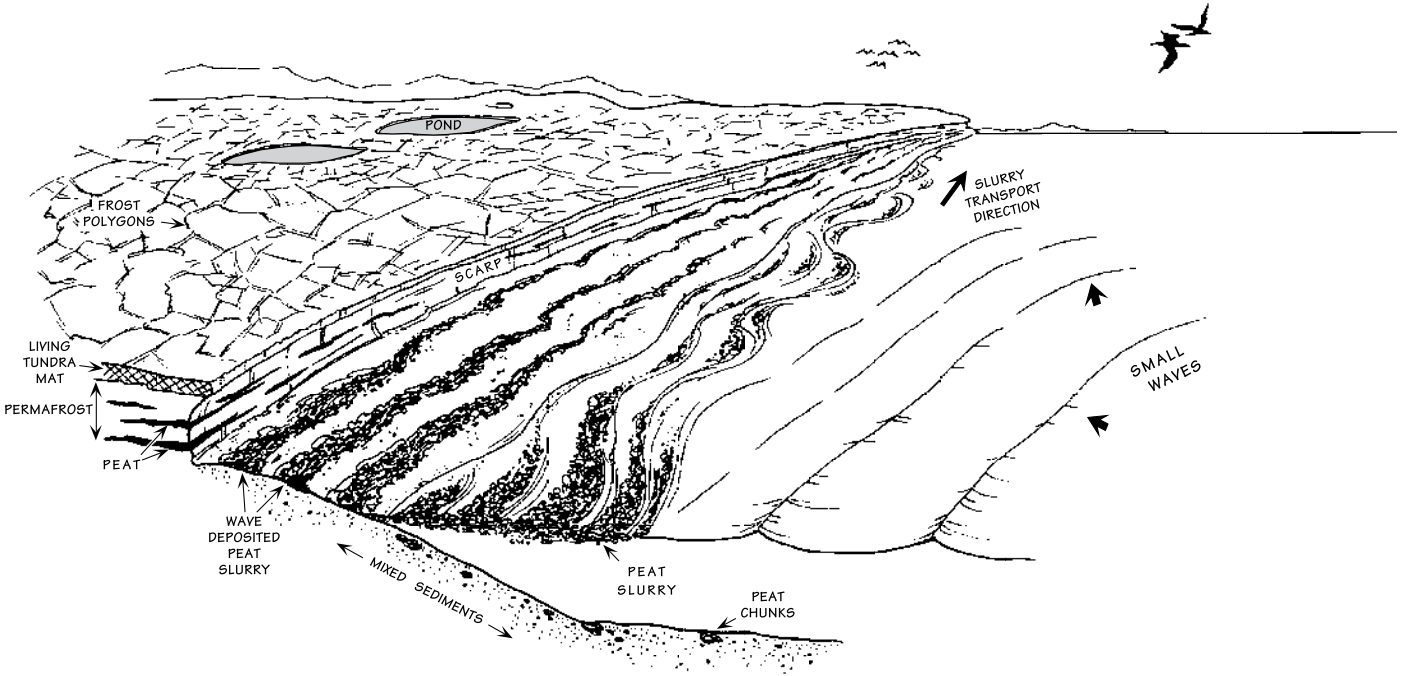
Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

A = The least adverse habitat impact.
B = Some adverse habitat impact.
C = Significant adverse habitat impact.
D = The most adverse habitat impact.
I = Insufficient information - impact or effectiveness of the method could not be evaluated.
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	B	B	B
Barriers/Berms	–	–	–	–	–
Manual Oil Removal/Cleaning	–	B	B	B	B
Mechanical Oil Removal	–	–	–	–	–
Sorbents	–	A	A	B	B
Vacuum	–	–	–	–	–
Debris Removal	–	A	A	A	A
Sediment Reworking/Tilling	–	–	–	–	–
Vegetation Cutting/Removal	–	–	–	–	–
Flooding (deluge)	–	–	–	–	–
Low-pressure, Ambient Water Flushing	–	A	B	C	C
High-pressure, Ambient Water Flushing	–	B	B	C	C
Low-pressure, Hot Water Flushing	–	–	C	C	C
High-pressure, Hot Water Flushing	–	–	C	C	C
Steam Cleaning	–	–	D	D	D
Sand Blasting	–	–	D	D	D
Solidifiers	–	–	–	–	–
Shoreline Cleaning Agents	–	–	B	B	B
Nutrient Enrichment	–	I	I	I	I
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	–	–	–	–


POND
FROST POLYGONS
SCARP
SLURRY TRANSPORT DIRECTION
LIVING TUNDRA MAT
PERMAFROST
PEAT
SMALL WAVES
WAVE DEPOSITED PEAT SLURRY
MIXED SEDIMENTS
PEAT SLURRY
PEAT CHUNKS

Description

- This shoreline type includes exposed peat scarps, eroded peat, and peat slurries.
- Exposed peat scarps occur where the peat is frozen.
- They are highly erosional (>1 meter/year), resulting from wave action, ice scour, and melting of the frozen peat.
- The intertidal zone is often very complex, with slumped peat blocks and a thin (and temporary) sand layer on the peat.
- Eroded peat occurs as a peat mat or veneer in a dewatered state, deposited on a sand or gravel beach; it is usually less than 20 cm thick and considered to be relatively transient.
- Peat slurries (which have the appearance of coffee grounds) are up to 50 cm thick and 10 meters wide.
- Peat slurries are found at the foot of eroding peat scarps and in depositional areas; they are relatively permanent features that move along the shore with the currents.
- Peat shorelines comprise about 70 percent of the Beaufort Sea coast of Alaska.
- The intertidal zone of this shoreline type is not particularly important as biological habitat.

Predicted Oil Behavior

- Oil could be stranded onshore only during the ice-free summer season.
- Oil penetration and persistence are expected to be very low in frozen peat scarps.
- Light oil can penetrate peat slurries, especially when the peat is dry.
- Peat resists penetration by heavy oils, even when dry.
- Peat slurry reacts with oil like loose granular sorbent and will partially contain and prevent the oil from spreading.

Response Considerations

- The peat substrate is soft, thus cleanup will be difficult; trampling is less of concern where peat is frozen or work is conducted from boats.
- Substrate disruption is of limited concern because of high erosion rates so long as adjacent tundra is not disturbed.
- Peat slurry may be used as a natural sorbent; sorption will be more effective with liquid and fresh oils.
- With high erosion rates, stranded oil will have a short residence time.
- Tundra cliffs are commonly undercut and naturally unstable, so safety is a primary concern during response operations.
- Hot-water washing or even low-pressure flushing activities are not appropriate because large quantities of peat could be eroded from the treatment area.

INTERTIDAL: Peat Shores

Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

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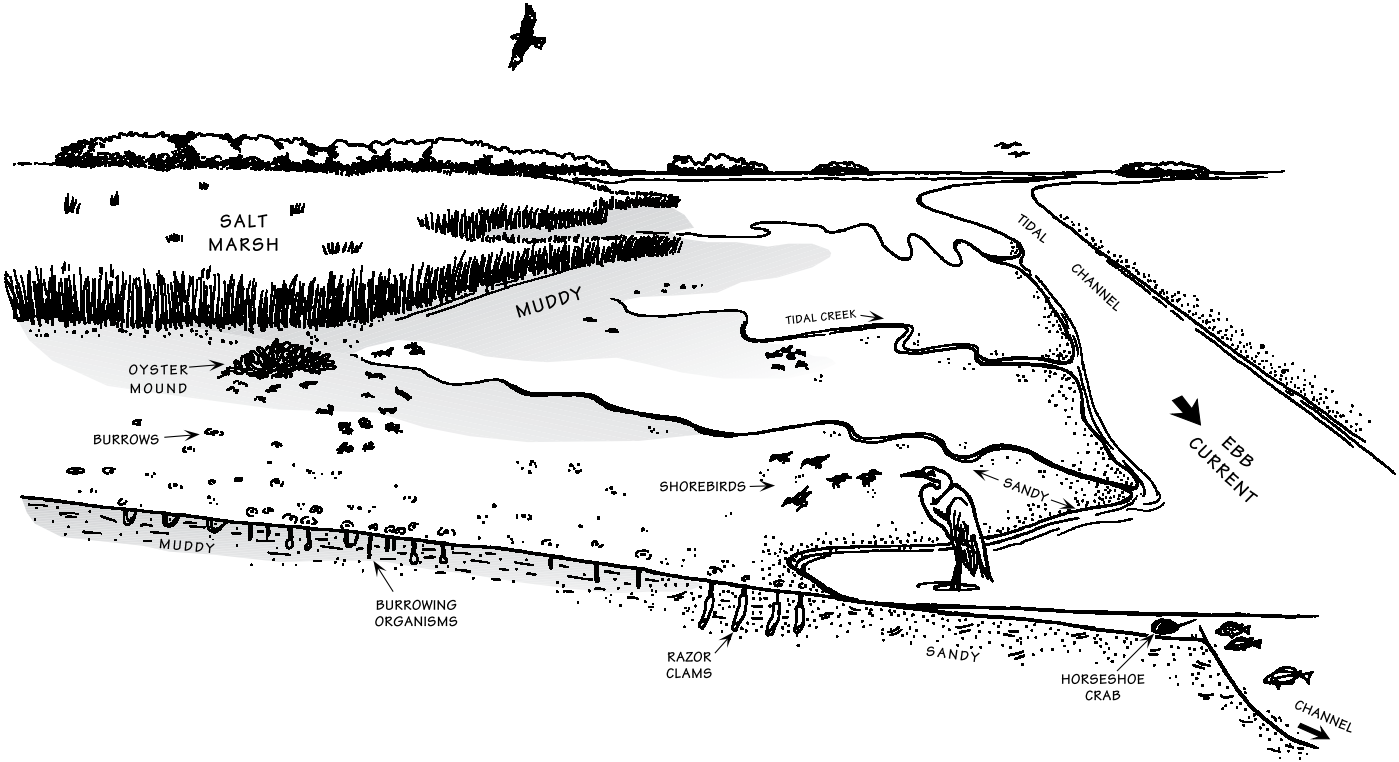
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	A	A	A
Barriers/Berms	–	–	–	–	–
Manual Oil Removal/Cleaning	C	B	B	B	B
Mechanical Oil Removal	D	D	D	D	D
Sorbents	–	A	A	B	B
Vacuum	–	B	B	B	B
Debris Removal	C	B	B	B	B
Sediment Reworking/Tilling	C	C	B	B	B
Vegetation Cutting/Removal	D	D	C	C	C
Flooding (deluge)	C	B	B	C	D
Low-pressure, Ambient Water Flushing	C	B	B	C	D
High-pressure, Ambient Water Flushing	–	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–	–
Steam Cleaning	–	–	–	–	–
Sand Blasting	–	–	–	–	–
Solidifiers	–	–	–	–	–
Shoreline Cleaning Agents	–	–	–	–	–
Nutrient Enrichment	–	B	B	C	C
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	–	–	–	–


SALT MARSH
MUDDY
TIDAL CREEK
TIDAL CHANNEL
OYSTER MOUND
BURROWS
EBB CURRENT
SHOREBIRDS
SANDY
MUDDY
BURROWING ORGANISMS
RAZOR CLAMS
SANDY
HORSESHOE CRAB
CHANNEL

INTERTIDAL: Sheltered Tidal Flats

Description

- Sheltered tidal flats are composed primarily of mud with minor amounts of sand and shell.
- They are usually present in calm-water habitats, sheltered from major wave activity, and frequently backed by marshes.
- The sediments are very soft and cannot support even light foot traffic in many areas.
- There can be large concentrations of bivalves, worms, and other invertebrates in the sediments.
- They are heavily used by birds for feeding.

Predicted Oil Behavior

- Oil does not usually adhere to the surface of sheltered tidal flats, but rather moves across the flat and accumulates at the high-tide line.
- Deposition of oil on the flat may occur on a falling tide if concentrations are heavy.
- Oil will not penetrate the water-saturated sediments, but could penetrate burrows and desiccation cracks or other crevices in muddy sediments.
- In areas of high suspended sediment concentrations, the oil and sediments could mix, resulting in the deposition of contaminated sediments on the flats.
- Biological impacts may be severe.

Response Considerations

- These are high-priority areas for protection since cleanup options are limited.
- Cleanup of the flat surface is very difficult because of the soft substrate; many methods may be restricted.
- Low-pressure flushing, vacuum, and deployment of sorbents from shallow-draft boats may be attempted.

Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

A = The least adverse habitat impact.
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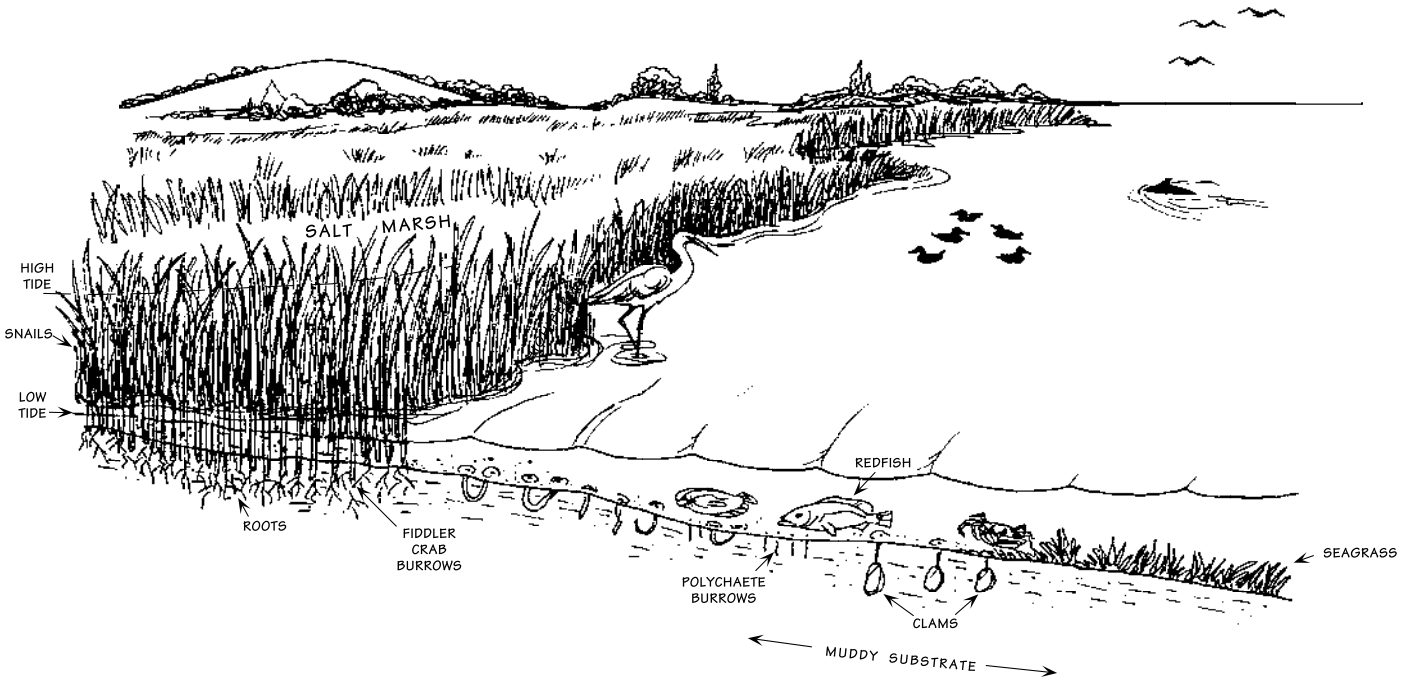
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	B	B	B
Barriers/Berms	D	C	C	C	C
Manual Oil Removal/Cleaning	–	D	C	C	–
Mechanical Oil Removal	–	–	–	–	–
Sorbents	–	A	A	B	B
Vacuum	–	C	B	B	B
Debris Removal	–	B	B	B	B
Sediment Reworking/Tilling	–	–	–	–	–
Vegetation Cutting/Removal	–	–	D	D	D
Flooding (deluge)	–	B	B	B	C
Low-pressure, Ambient Water Flushing	–	C	C	D	D
High-pressure, Ambient Water Flushing	–	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–	–
Steam Cleaning	–	–	–	–	–
Sand Blasting	–	–	–	–	–
Solidifiers	–	C	C	–	–
Shoreline Cleaning Agents	–	–	–	–	–
Nutrient Enrichment	–	I	I	I	I
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	–	–	–	–

INTERTIDAL: Salt to Brackish Marshes



Description

- Intertidal wetlands contain emergent, herbaceous vegetation, including both tidal and muted tidal marshes. Depending on location and interannual variations in rainfall and runoff, associated vegetation may include species tolerant or adapted to salt, brackish, or even tidal freshwater conditions.
- The marsh width may vary from a narrow fringe to extensive areas.
- Sediments are composed of organic muds except where sand is abundant on the margins of exposed areas.
- Exposed areas are located along bays with wide fetches and along heavily trafficked waterways.
- Sheltered areas are not exposed to significant wave or boat wake activity.
- Abundant resident flora and fauna with numerous species and high use by birds, fish, and shellfish.

Predicted Oil Behavior

- Oil adheres readily to intertidal vegetation.
- The band of coating will vary widely, depending upon the water level at the time of oiling.
- Large slicks will persist through multiple tidal cycles and will coat the entire stem from the high-tide line to the base.
- Heavy oil coating will be restricted to the outer fringe of thick vegetation, although lighter oils can penetrate deeper, to the limit of tidal influence.
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool on the surface or in animal burrows and root cavities.
- Light oils can penetrate the top few centimeters of sediment; under some circumstances oil can penetrate burrows and cracks up to one meter.

Response Considerations

- Under light oiling, the best practice is to let the area recover naturally.
- Natural removal processes and rates should be evaluated before conducting cleanup.
- Heavily pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
- Cleanup activities should be carefully supervised to avoid damaging vegetation.
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the plants and disturbance of soft sediments must be minimized.
- Aggressive cleanup methods should only be considered when other resources (migratory birds, endangered species) are at greater risk from oiled vegetation left in place.

INTERTIDAL: Salt to Brackish Marshes

Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

A = The least adverse habitat impact.
B = Some adverse habitat impact.
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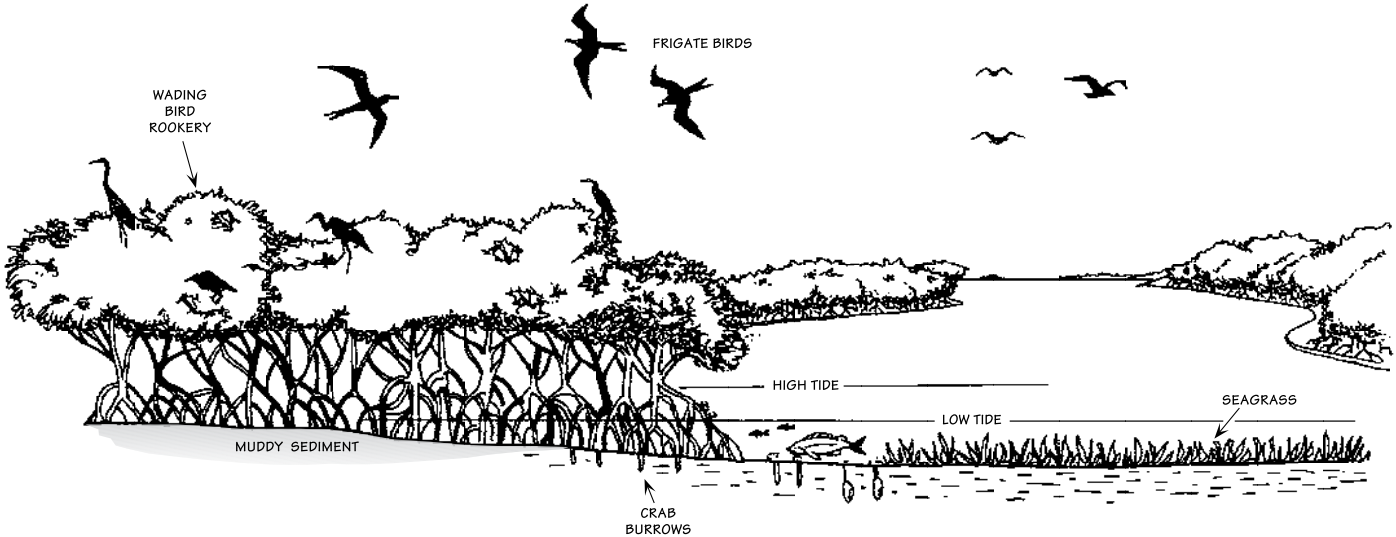
D = The most adverse habitat impact.
I = Insufficient information - impact or effectiveness of the method could not be evaluated.
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	B	B	B
Barriers/Berms	B	B	B	B	B
Manual Oil Removal/Cleaning	D	D	C	C	C
Mechanical Oil Removal	D	D	D	D	D
Sorbents	–	A	A	A	B
Vacuum	–	B	B	B	B
Debris Removal	–	B	B	B	B
Sediment Reworking/Tilling	D	D	D	D	D
Vegetation Cutting/Removal	D	D	C	C	C
Flooding (deluge)	B	B	B	B	B
Low-pressure, Ambient Water Flushing	B	B	B	B	B
High-pressure, Ambient Water Flushing	–	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–	–
Steam Cleaning	–	–	–	–	–
Sand Blasting	–	–	–	–	–
Solidifiers	–	C	C	–	–
Shoreline Cleaning Agents	–	–	B	B	I
Nutrient Enrichment	–	A	B	B	B
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	B	B	B	C


FRIGATE BIRDS
WADING BIRD ROOKERY
HIGH TIDE
LOW TIDE
SEAGRASS
MUDDY SEDIMENT
CRAB BURROWS

INTERTIDAL: Mangroves

Description

- The roots and trunks are intertidal, with only the lowest leaves inundated by high tide.
- The width of the forest can range from one tree, to many kilometers.
- The substrate can be sand, mud, leaf litter, or peat, often as a veneer over bedrock.
- Wrack accumulations can be very heavy.
- They are highly productive, serve as nursery habitat, and support a great diversity and abundance of animal and plant species.

Predicted Oil Behavior

- Oil can wash through mangroves if oil comes ashore at high tide.
- If there is a berm or shoreline present, oil tends to concentrate and penetrate into the berm sediments or accumulated wrack/litter.
- Heavy and emulsified oil can be trapped in thickets of red mangrove prop roots or dense young trees.
- Oil readily adheres to prop roots, tree trunks, and pneumatophores.
- Re-oiling from resuspended or released oil residues may cause additional injury over time.
- Oiled trees start to show evidence of effects (leaf yellowing) weeks after oiling; tree mortality may take months, especially for heavy oils.

Response Considerations

- Oiled wrack can be removed once the threat of oiling has passed. Wrack can actually protect the trees from direct oil contact.
- Sorbent boom can be placed in front of oiled forests to recover oil released naturally.
- In most cases, no other cleanup activities are recommended.
- Where thick oil accumulations are not being naturally removed, low-pressure flushing or vacuum may be attempted at the outer fringe.
- No attempt should be made to clean interior mangroves, except where access to the oil is possible from terrestrial areas.
- It is extremely important to prevent disturbance of the substrate by foot traffic; thus most activities should be conducted from boats.

Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

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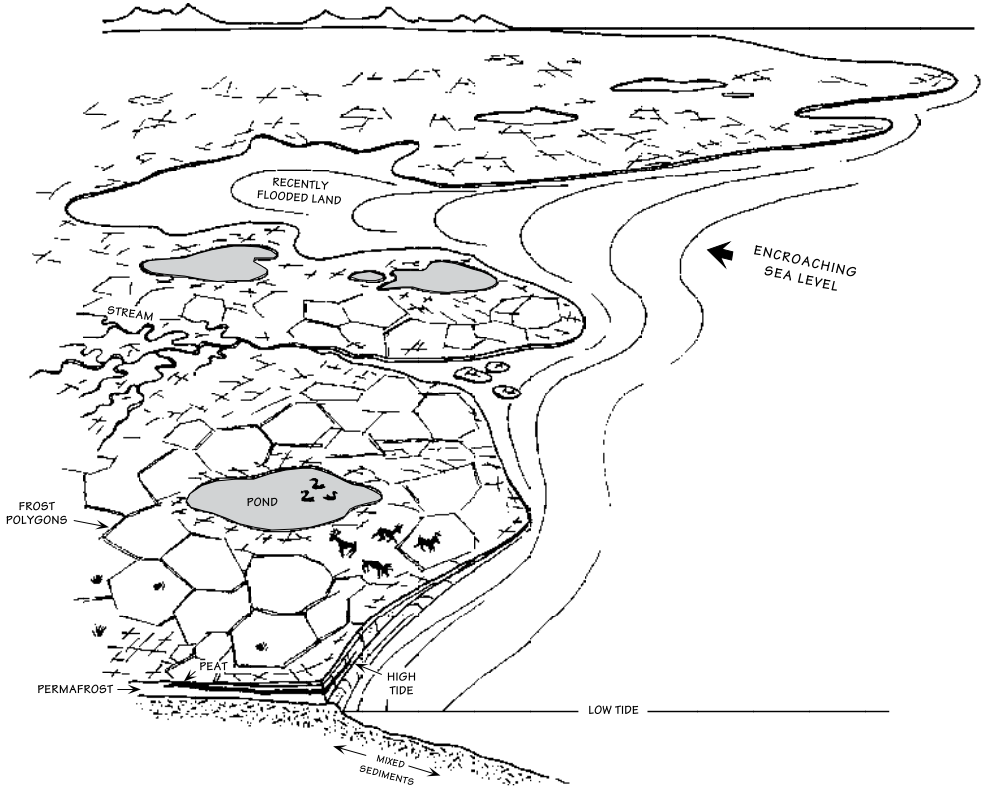
C = Significant adverse habitat impact.
D = The most adverse habitat impact.
I = Insufficient information - impact or effectiveness of the method could not be evaluated.
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	A	A	A
Barriers/Berms	B	B	B	B	B
Manual Oil Removal/Cleaning	–	D	C	C	C
Mechanical Oil Removal	–	–	–	–	–
Sorbents	–	A	A	A	B
Vacuum	–	B	B	B	B
Debris Removal	–	A	A	A	A
Sediment Reworking/Tilling	–	–	–	–	–
Vegetation Cutting/Removal	–	–	–	–	–
Flooding (deluge)	–	B	B	B	B
Low-pressure, Ambient Water Flushing	–	B	C	C	C
High-pressure, Ambient Water Flushing	–	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–	–
Steam Cleaning	–	–	–	–	–
Sand Blasting	–	–	–	–	–
Solidifiers	–	C	C	–	–
Shoreline Cleaning Agents	–	–	C	C	C
Nutrient Enrichment	–	I	I	I	I
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	–	–	–	–

INTERTIDAL: Inundated Lowland Tundra



Description

- This shoreline type occurs where very low-lying sections of the Arctic shoreline have been recently flooded by the sea, due to subsidence.
- Also includes areas that are not normally in the intertidal zone but can be frequently inundated by salt water during spring tides or wind-induced surges.
- They have complex and convoluted shorelines comprised of tundra, vegetated flats, river banks, peat mats, brackish lagoons, and small streams.
- These shorelines have high ice content; the surface material is mostly peat with little mineral sediments.
- Where present, the vegetation is salt-tolerant and may be more adapted to drier conditions than the salt marshes.
- The tundra is a living plant community and provides important feeding areas for migrating birds in the summer.

Predicted Oil Behavior

- Oil could be stranded onshore only during the ice-free summer season.
- During storm surges, spilled oil could strand hundreds of meters inland.
- During the summer months, the surface sediments/peat deposits are usually water-saturated, so stranded oil is likely to remain on the surface.
- Physical removal rates of medium to heavy oils will be slow.

Response Considerations

- In summer, the substrate will be too soft to support foot or vehicular traffic; any work will require construction of walkways or roads.
- In winter, such work will be less damaging when the load-bearing capacity of these low-lying areas is increased.
- Excessive physical disruption can completely alter the substrate, hydrology, and vegetation patterns for many years.
- Avoid raking and trampling oil into living plants.
- Peat may be used as a natural sorbent; sorption will be more effective with liquid and fresh oils.
- Low-pressure, ambient-water flood and/or flushing could raise the local water table to float and direct oil towards a boomed area for collection.
- If salt-tolerant species are present, seawater may be used; use fresh water only if freshwater species are present.
- Consider burning only where there is an insulating water layer to protect roots and prevent deeper penetration into the substrate. Peat with a high water content may make burning ineffective, leaving a persistent surface residue that is more difficult to remove than the spilled oil.

INTERTIDAL: Inundated Lowland Tundra

Oil Category Descriptions

I – Gasoline products
II – Diesel-like products and light crudes
III – Medium grade crudes and intermediate products
IV – Heavy crudes and residual products
V – Non-floating oil products

The following categories are used to compare the relative environmental impact of each response method in the specific environment and habitat for each oil type. The codes in each table mean:

A = The least adverse habitat impact.
B = Some adverse habitat impact.
C = Significant adverse habitat impact.
D = The most adverse habitat impact.
I = Insufficient information - impact or effectiveness of the method could not be evaluated.
– = Not applicable.

	Oil Category				
Response Method	**I**	**II**	**III**	**IV**	**V**
Natural Recovery	A	A	A	B	B
Barriers/Berms	–	–	–	–	–
Manual Oil Removal/Cleaning	D	C	C	C	C
Mechanical Oil Removal	D	D	C	C	C
Sorbents	–	C	C	C	–
Vacuum	–	B	B	B	C
Debris Removal	–	C	C	C	C
Sediment Reworking/Tilling	–	–	–	–	–
Vegetation Cutting/Removal	D	D	D	D	D
Flooding (deluge)	C	C	C	D	–
Low-pressure, Ambient Water Flushing	–	D	D	–	–
High-pressure, Ambient Water Flushing	–	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–	–
Steam Cleaning	–	–	–	–	–
Sand Blasting	–	–	–	–	–
Solidifiers	–	C	C	–	–
Shoreline Cleaning Agents	–	–	–	–	–
Nutrient Enrichment	–	I	I	I	I
Natural Microbe Seeding	–	I	I	I	I
In-situ Burning	–	C	C	C	–