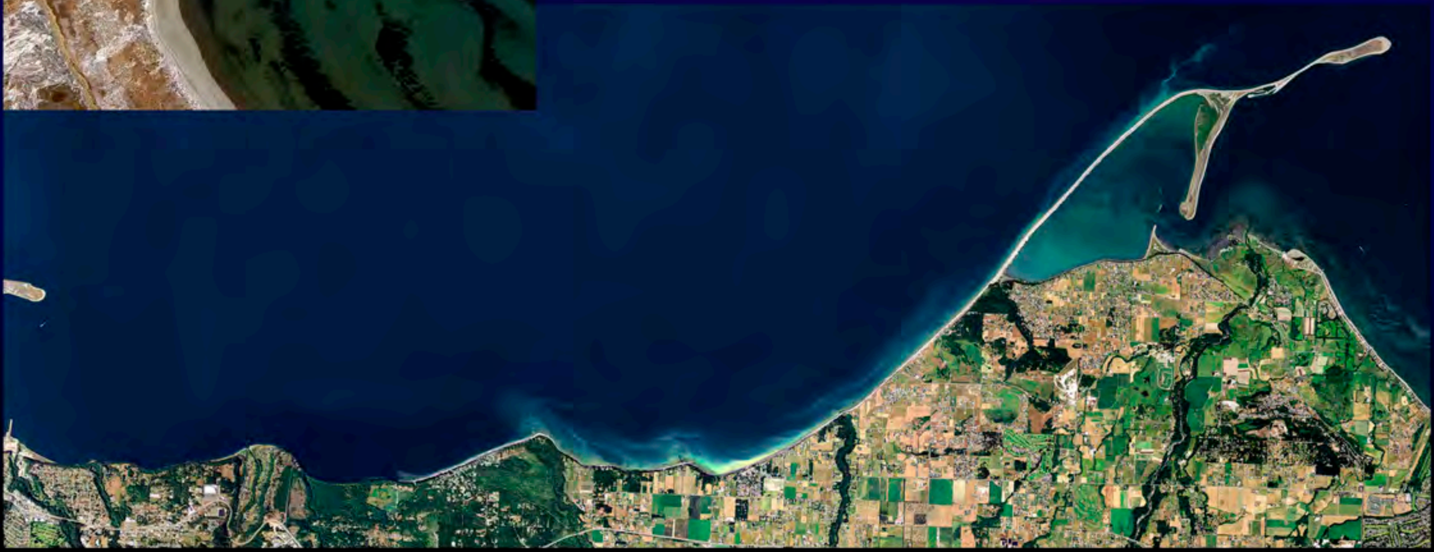
Dungeness Drift Cell

Parcel Prioritization and Conservation Strategy



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Dungeness Drift Cell: Land Parcel Prioritization and Conservation Strategy

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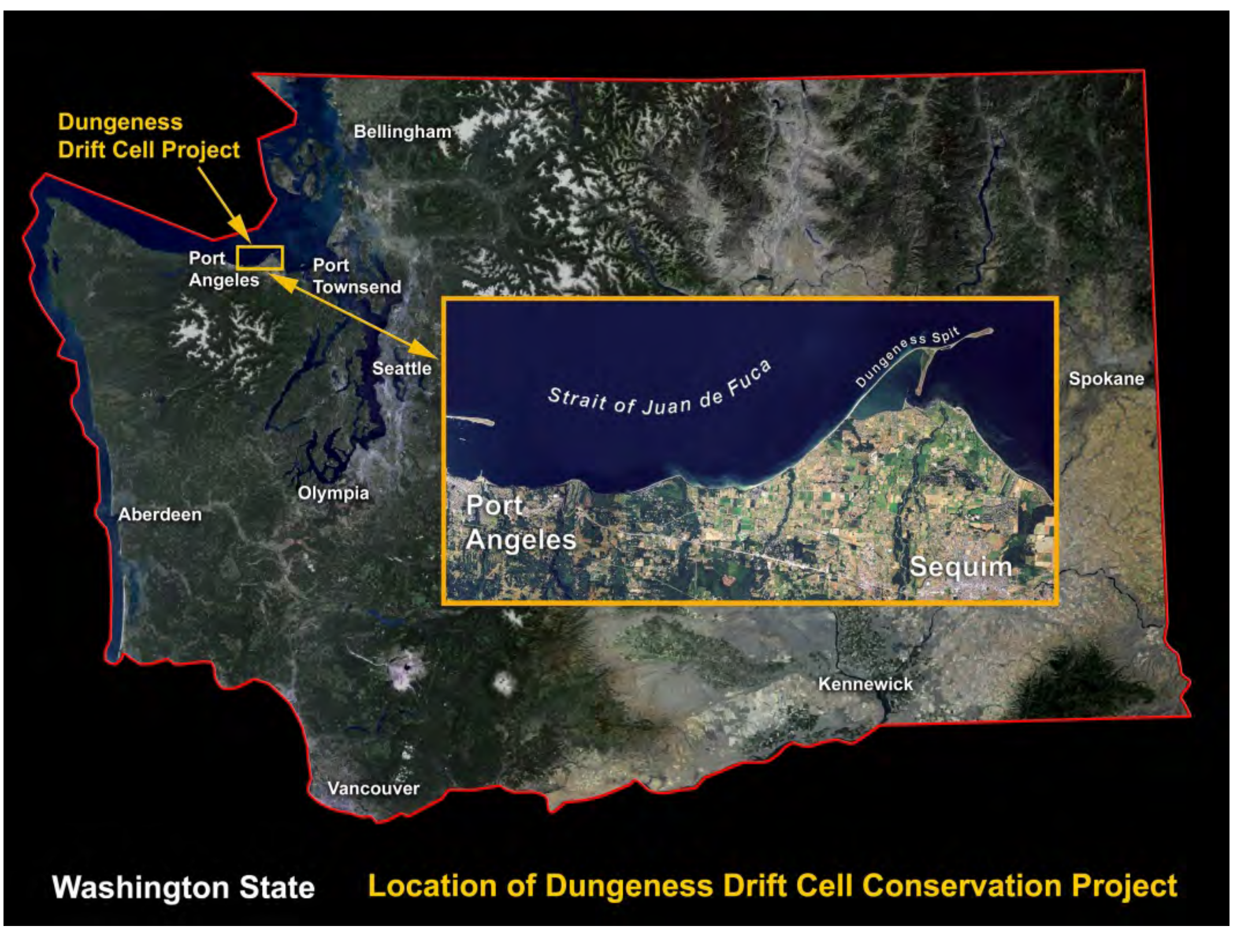


Figure 1: Project Location Map. The Dungeness Drift Cell is located on the North Olympic Peninsula of Washington State.

Introduction

The 5-mile long Dungeness Spit and its associated 5-square mile Dungeness Bay are national treasures for their immense scenic, recreational, and natural resource values. The Spit and Bay are the centerpieces of a national wildlife refuge, which is a major recreational destination for beach walking, birding, wildlife watching, and crabbing. A multitude of healthy and imperiled fish and wildlife species, including salmon, char, marine mammals, wading birds, waterfowl, raptors, and butterflies, inhabit the rich estuarine ecosystem created by the Spit. The Bay contains bountiful populations of clams, oysters, and crab. A half mile from the end of the Spit stands the historic New Dungeness Lighthouse, built in

Figure 2: Dungeness Spit and Dungeness Bay

1857. To the Jamestown S'Klallam Tribe, the Spit and Bay are supremely important cultural resources.

Aquatic habitats on the northern Olympic Peninsula, including Dungeness Bay, support salmon and shellfish populations that are important economic resources and are integral to the Jamestown S'Klallam Tribe's cultural identity. Over the past 100 years many of these fish populations have declined significantly, and thus a major goal of the Tribe is to restore and conserve healthy, harvestable, and sustainable numbers of traditional fish and shellfish. Since the 1980's the Tribe has worked to conserve shorelines, protect water quality, and restore habitat forming processes in local rivers and bays, especially the Dungeness River, Jimmycomelately Creek, Dungeness Bay, Washington Harbor, and Sequim Bay. A part of this work is focused on ensuring the continued existence and health of the area's natural spits, which not only provide valuable fish and wildlife habitat and are important cultural sites for the Tribe, but also create bays, harbors, and protect shorelines from erosion by waves.

The Drift Cell

Made only of highly erodible sand, gravel, and cobbles, Dungeness Spit and its Bay protrude deep into the stormy waters of the Strait of Juan de Fuca. Powerful forces erode shorelines to the west and east, while the Spit remains intact. Upon the Spit, strong waves push sediment east until it is lost into deep water (depth ≥ 240 feet, Figure 4). For each grain of sand that traverses the length of the Spit and then disappears off its tip, replacement sand must arrive or the Spit will begin eroding away.

Many marine shorelines receive some amount of sediment from one source or another. In Washington, the most common sources are the erosion of uplands bordering the shoreline and the silt, sand, and gravel delivered by freshwater streams. Once on the beach, sediment is moved along the shoreline by

Figure 3: Strait of Juan de Fuca, Dungeness Spit, Graveyard Spit, and Dungeness Bay

waves, tidal currents, and winds. This movement is called *longshore drift*. Often sediment will move in predominately one direction - *down-drift*. Sediment also moves away from shore into deep water and this is called *offshore drift*. In some rare locations a significant and continuous supply of sediment moves along the shoreline in predominately one direction and accumulates into an accretion shoreline feature, such as a spit. This combination of a sediment supply and an accretion landform is called a *drift cell*.

Dungeness Spit was formed and is maintained (fed) by a steady supply of sediment delivered to the Strait from nearby streams, most notably Morse, Siebert and McDonald Creeks, and a complex of eroding coastal bluffs. These sediment sources along with the Spit itself comprise the Dungeness Spit Drift Cell (hereafter referred to as the Dungeness Drift Cell or drift cell). The great majority of the Spit's sediment comes from bluff erosion. The complex of high bluffs stands generally 100 to 240 feet in height and extends west of the Spit for 10.4 miles. The bluffs erode at various rates - on average one foot per year – and deliver an enormous quantity of sediment to the beach. Driven east by waves and currents, a percentage of the sand, gravel, and cobbles reaches and maintains the Spit. Without this constant nourishment the Spit and hence the Bay would wash away.

Figure 4: Sediment Drifting Off Dungeness Spit

The drift cell's down-drift terminus is the tip of Dungeness Spit. By examining historic and contemporary air photos and consulting data provided by Coastal Geologic Services, we concluded that the up-drift boundary of the Dungeness Drift Cell lies approximately at the mouth of Lee's Creek near Port Angeles, some 10.5 coastline miles west of Dungeness Spit. Along the south shore of Dungeness Bay, a slowly eroding bluff extends for 1.5

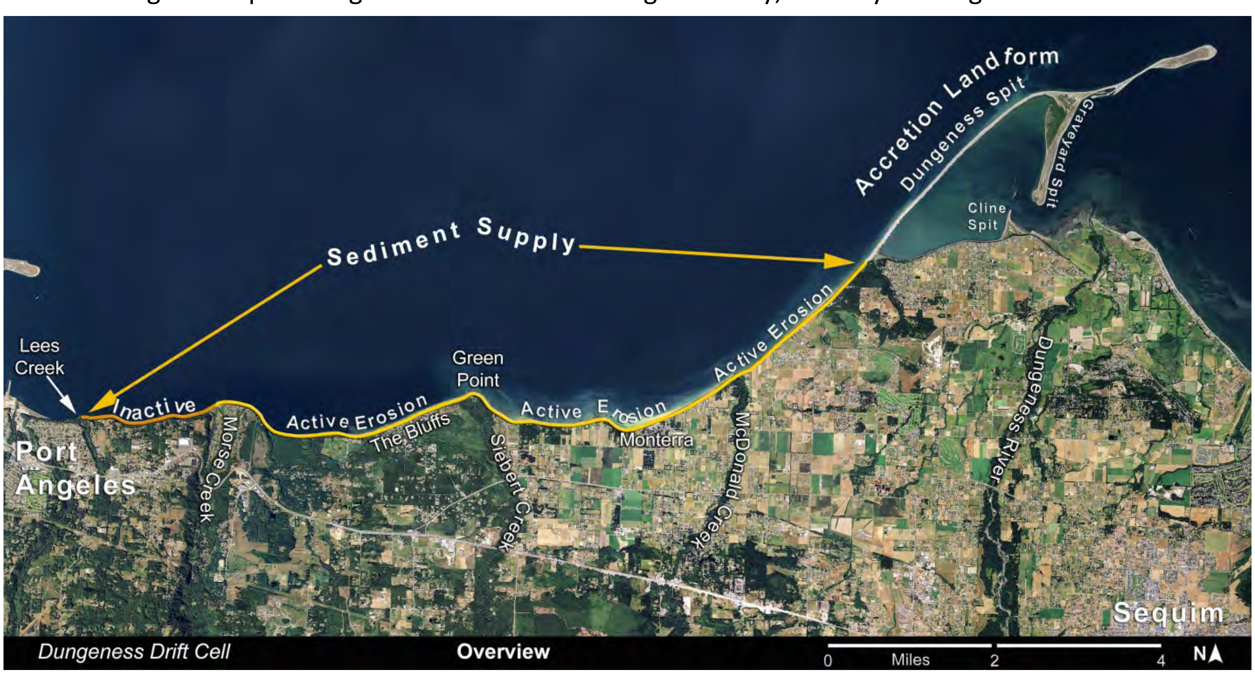


Figure 5: Dungeness Drift Cell

miles between the base of Dungeness Spit and Cline Spit. Sediment derived from the Dungeness Bay bluff drifts primarily east to Cline Spit and little, if any, of this sediment reaches Dungeness Spit. The Dungeness River contributes sediment to Cline Spit and possibly a small quantity to Graveyard Spit. The River does not appear to contribute any significant amount of sediment to Dungeness Spit.

Figure 7: Feeder Bluff in the Dungeness Drift Cell

Spits at Risk

Ediz Hook in Port Angeles provides a case history relevant to the conservation of Dungeness Spit. Located 10 miles west of Dungeness Spit, the Hook is a once-natural spit which similarly protrudes deep into the wave-swept Strait of Juan de Fuca. In early photographs Ediz Hook looks much like today's Dungeness Spit. Ediz Hook's drift cell extends about 4.7 miles west of the Hook to the Elwha River mouth and is fed by sediment originating from the Elwha River and from eroding bluffs, including a 3-mile stretch of especially erodible feeder bluff. In a 1972 report, the U.S. Army Corps of Engineers estimated that prior to human disturbance, approximately 15 percent of the drift cell's sediment originated from the Elwha River and 85 percent originated from bluff erosion. The Corps estimated that by the 1930's the combined effects of the Elwha River dams and bulkheading along the bluffs had

Figure 6: Ediz Hook 1884 and 1997, and Ediz Hook Feeder Bluffs

decreased sediment inputs to the drift cell by about 75 percent. By the late 1930's Ediz Hook had begun eroding so severely that major bulkheading projects commenced along its shoreline. The Corps attributes the sudden, dramatic erosion of the Hook to the effect of reduced sediment recruiting into the drift cell. By 1951 it had become necessary to armor virtually the entire outer shoreline of Ediz Hook to prevent the Hook from eroding away. By the 1960's the Hook's bulkheads were undermined and failing to such an extent that local forces – the City of Port Angeles, the Crown Zellerbach Mill, and the U.S. Coast Guard – could no longer keep pace, and thus the Corps was petitioned to intervene. In 1973 the Corps accepted responsibility for maintaining the Hook, beginning with a $4,890,000 revetment project and a projection of $423,800 in perpetually required annual maintenance. The Ediz Hook experience clearly demonstrates that Dungeness Spit and its ecosystem can remain healthy only as long as natural quantities of sediment continue drifting to the Spit.

Dungeness Drift Cell Conservation

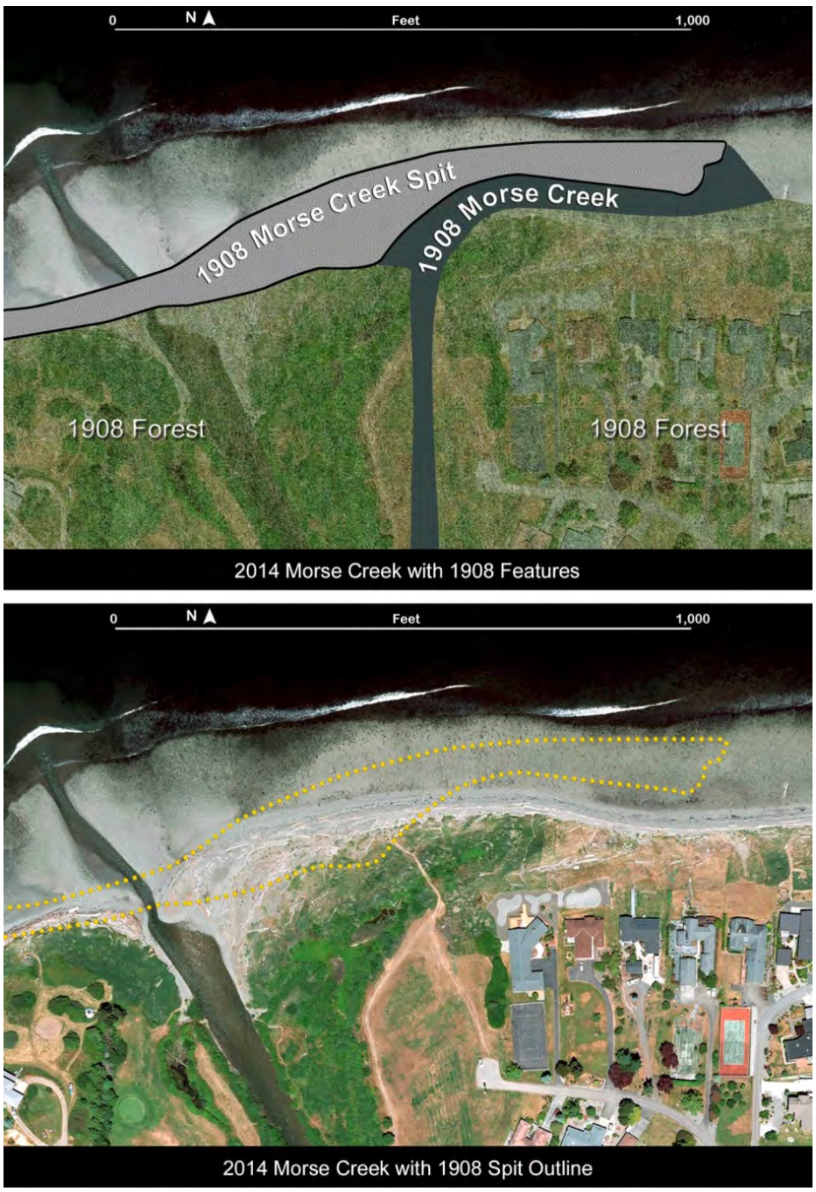


Figure 8: Former Morse Creek Spit

Since the mid-1800's when Europeans began settling in the Dungeness Drift Cell, the bluff tops have been increasingly logged, farmed, and then built up with residential buildings and infrastructure. As the bluffs naturally erode and deliver their sediment to the beach, structures built atop the bluffs become ever closer to the edge. Once a structure becomes imperiled by a retreating bluff, property owners have generally responded by retreating themselves: demolishing, abandoning, or moving their structure farther landward. In several limited cases landowners have attempted to halt the natural erosion in front of their structure by placing rip rap at the bluff's toe.

By 2013 slightly more than 1.5 miles (15%) of the drift cell's bluff shoreline had been treated with some type of erosion control measure, most commonly the placement of rock rip rap armoring. The majority (1.5 miles) of this armoring consists of a 1915 railroad grade, now converted to the Olympic Discovery Trail, located along the westernmost reach of the drift cell, between Lee's Creek and Morse Creek. The railroad grade was not built specifically to serve as shoreline armoring, but its length is armored with rip rap to prevent the grade itself from eroding. Although the railroad grade is located both directly against and in some locations seaward of the bluff toe, it has not completely stopped erosion of the "protected" bluff which continues to slump and slide. Fortunately, this upper end of the drift cell does not appear to have been a historically important sediment source for Dungeness Spit. However, the Morse Creek Spit, a small accretion landform once located immediately down-drift of the 1.5 miles of armored bluff, declined from being intact in 1939 to being entirely eroded

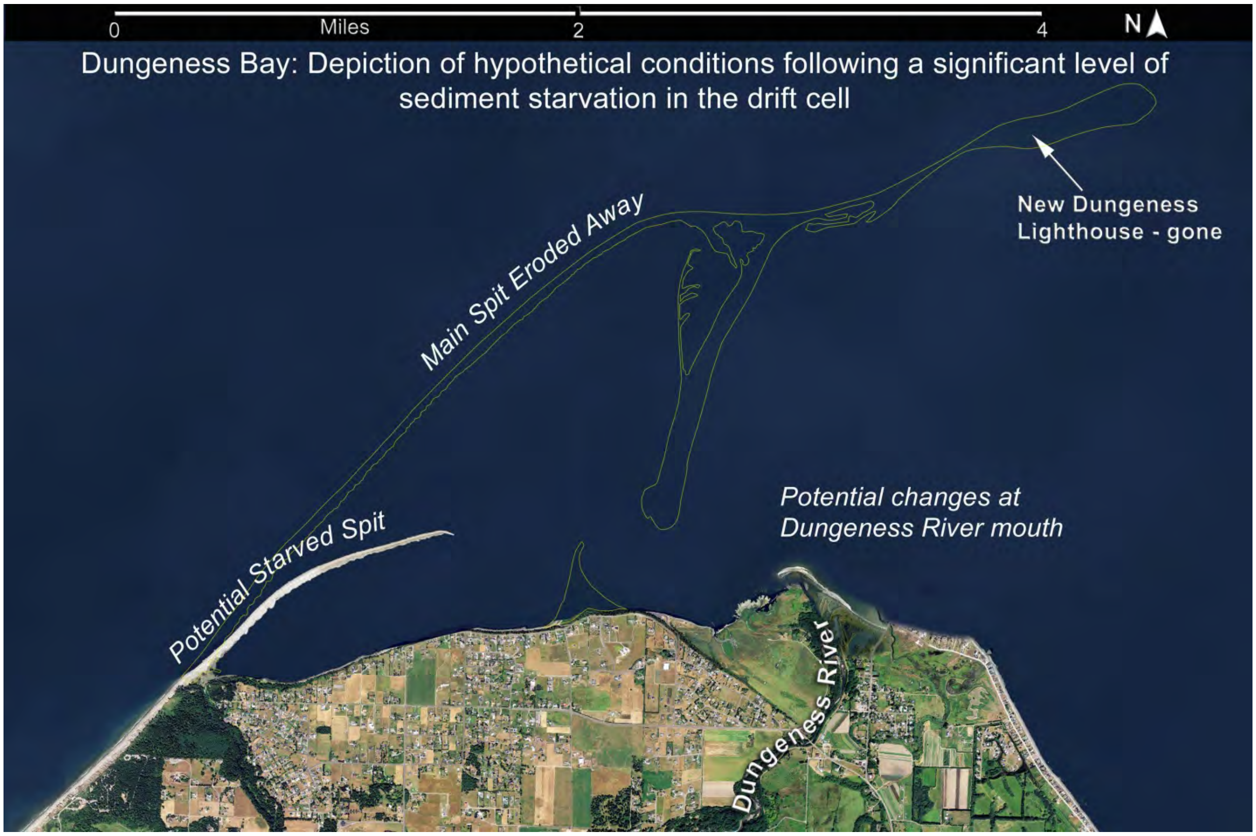


Figure 9: Hypothetical Conditions at Dungeness Bay Following Potential Drift Cell Starvation

away and disappeared by 2005 (Figure 8).Because tall, highly erodible bluffs are costly to armor and maintain, the drift cell's most active sediment-generating feeder bluffs remain un-armored. However, as residential and commercial development continues upon the bluffs, concern increases that harmful shoreline armoring will begin to occur, with the possible result that Dungeness Spit will then become sediment starved, begin eroding away, and ultimately disappear forever along with its Bay. In an effort to ensure that this potential economic, environmental and cultural catastrophe never occurs, the Tribe and other stakeholders have begun developing a strategy to permanently conserve Dungeness Drift Cell sedimentary processes. The primary conservation tools proposed for use are 1) the direct conservation of feeder bluff properties by purchasing either fee-simple titles or conservation easements, and 2) the implementation of voluntary incentives for landowners to permanently refrain from armoring their feeder bluff properties. An essential step required to effectively implement these tools is to first prioritize the drift cell land parcels based on their potential to deliver sediment to Dungeness Spit.

Drift Cell Miles

To provide a consistent, simple, and accurate method for referring to locations or segments along the drift cell, we use *drift cell miles* (DCMs), which are similar in concept to river miles (Figure 10). Beginning at the ordinary high water mark at the spit's terminus, a line is traced and measured the entire length of the drift cell. The line follows the spit's crest, moving updrift towards the sediment source. Beyond the spit, drift cell miles continue to be measured at roughly the toe of the bluff. Where stream mouths are crossed, a straight line is drawn across the mouth between bluff toes. The drift cell mile line ends at the uppermost point where sediment bound for the spit reaches the beach. In the Dungeness Drift Cell, we estimated that this point is located at the mouth of Lees Creek, DCM 15.55.

Figure 10: Dungeness Spit Drift Cell with Drift Cell Miles (DCM's). Imagery NAIP 2013

Prioritization of Land Parcels

The conservation project's goal is to ensure the continued delivery of sediment to the Spit in natural quantities and by natural means, for a planning period of 200 years. To prioritize land parcels for conservation, it is crucial to know the relative quantity of sediment recruiting from various bluff locations and ultimately reaching the Spit. Because they have an undefined and relatively minor importance to Dungeness Spit, those bluff sediments originating west of Morse Creek (fully armored since 1915) and east of Dungeness Spit's base, along with the sediments delivered by the various streams, are not considered here. This planning effort focuses solely on the marine bluffs between Morse Creek and Dungeness Spit, Drift Cell Mile 5.10 to 13.55. We further narrowed our focus to exclude publicly owned parcels, public and private roads, and the few armored parcels just east of Morse Creek. Figure 11 shows the area of focus.

The Focus Area

The focus area includes approximately 8 miles of shoreline along the shoreline bluff top. Except where the stream valleys of McDonald, Siebert, and Bagley Creeks have cut notches, the bluffs are continuous throughout this reach. Much of the area landward of the bluff crest is a relatively flat glacial plain. Bluff top properties near the bluff edge afford marine and mountain views making them popular for residential development. The area within the former lake bottom at Lake Farm road is an exception with an incline from much of the property up to the bluff crest.

The entire focus area is zoned for residential development, with some 70% of the parcels developed by mid-2014. Parcels are generally rectangular with sizes ranging from 0.14 acres to 47.85 acres. Although

Figure 11: Dungeness Drift Cell- Prioritization Focus Area 2014

much of the development is rural in nature, two residential developments, Monterra and "The Bluffs", were developed at suburban densities. Many of their shoreline lots are approximately 100-feet wide. These two developments contain about 40% of the focus area's total parcels, while occupying only 8% of the total area. Nine parcels along Gehrke Road, immediately east of Green Point, are also smaller and clustered more tightly than those in the adjacent areas.

For prioritization, we selected land parcels (Clallam County 2010) that border the shoreline and properties that are likely to become shoreline parcels during the next 200 years of bluff erosion. Slightly over 400 parcels fall within the 200 year erosion band. After removing roads and publicly owned parcels from the planning process, 382 privately owned parcels remained to be prioritized.

Erosion Rate Study

The first step taken to inform our prioritization effort was to estimate contemporary bluff erosion rates. We geo-rectified high resolution aerial photographs for the years 1956, 1976, 1997, 2008, and 2010, and then located the bluff edge at 64 reference locations for the maximum number of these years as was possible. Differences in bluff edge locations were measured and erosion rates, also known as *bluff recession rates,* were calculated. Associated Geographic Information System (GIS) datasets were created and are used throughout this prioritization.

Figure 12: Measurement of bluff erosion.

Criteria for Prioritizing Land Parcels

Several stakeholder meetings were hosted to discuss prioritization concepts and to identify criteria, including geophysical, social, economic and practical factors that could be used to prioritize parcels for conserving sediment delivery to Dungeness Spit. The stakeholders discussed a long list of criteria which were narrowed and combined to approximately a dozen important factors.

Stakeholders acknowledged that due to the number and diversity of parcels within the focus area, no single organization or funding source would likely to be able to fully implement the conservation strategies being developed by the Tribe and stakeholders. Since each organization and each funding source will have slightly different requirements and conservation tools, the stakeholders concluded that prioritization criteria should be grouped into two categories: Geophysical Criteria and Implementation Criteria. Geophysical criteria are those that best predict the relative volume of sediment that each parcel will likely deliver to the Spit over the next 200 years under natural conditions. Implementation Criteria are important factors that an organization would use to decide which of the high geophysical-priority parcels best fit their funding source, their organizational goals and capacities, and the conservation mechanisms available to them. Note: This document describes the Jamestown S'Klallam Tribes planning efforts and reflects the Tribe's priorities for implementation of Dungeness Drift Cell Conservation. Meanwhile, the North Olympic Land Trust (NOLT) is exploring additional conservation mechanisms that go beyond the typical acquisition via fee-simple or conservation easement. Appendix D results from the work completed by North Olympic Land Trust in partnership with the Jamestown S'Klallam Tribe with a grant from the Puget Sound Acquisition and Restoration fund, through their Project Implementation and Development Award, grant #14-1028.

Combining Criteria and weighting:

Potential prioritization criteria are expressed in a variety of units. For example, erosion rate = feet per year, distance from the base of the Spit = miles, parcel geometry = shoreline length/parcel depth, and parcel size = acres. To convert these criteria into comparable units, a simple additive multi-criteria decision system was used. In this system, all of the criteria are converted into unit-less values between zero and 1. This is accomplished by dividing all the values for a criterion by the highest value for that criterion (this is sometimes referred to as normalization). Some of the criteria are ratios or categorical data that do not require normalization. Once the values for each criterion are processed so they range from 1 to zero, they can be combined through simple addition. Although non-normal data will behave differently than normally distributed data using this method, we found that normalization combined with weighing of the criteria worked well for the needs of this project.

$$Prioritization\ score = cA + cB + \cdots$$

$$Weighted\ Prioritization\ score = 2(cA) + cB + cC + \cdots$$

Once normalized, each criterion is designed so that it can be used alone or combined with other criteria. Combining criteria is achieved through addition. Adding a number of criteria together will result in a prioritization (score) for each parcel. Where criterions are not equal in their relative importance, weighting can be used. Weighting simply involves placing a multiplier next to criteria that are more important than others. For example, multiplying Criterion A times two, then adding it to Criteria B and C will result in a prioritization score where Criterion A has twice as much influence on the outcome as either B or C. This will be further explained using examples given below.

Geophysical Sediment Delivery Prioritization

The relative amount of sediment contributed to Dungeness Spit from any given parcel is determined by numerous factors, which can be placed in two categories:

- *Factors affecting the quantity of sediment delivered to the beach*. This includes the parcel's location relative to the bluff edge, bluff height, composition, and erosion rate.
- *Factors affecting the percentage of sediment reaching the Spit*. This includes the parcel's proximity to the Spit and its location within the drift cell relative to features that affect longshore drift, such as Green Point.

Delivery to the beach:

The most basic factor influencing the quantity of material delivered to the beach from a given parcel is whether or not that parcel currently contains an eroding bluff. This criterion is labeled "First Row" (Table 1). A First Row parcel is a property that is located against the shoreline and is currently eroding at some rate. A Second Row parcel is located with the 200-year erosion band but is landward of another parcel and is not currently delivering any sediment to the beach. Second Row parcels will begin to produce sediment later in the 200-year planning period, after the adjacent First Row parcel has eroded entirely away. While the conservation project's goal is to conserve the natural sediment supply and natural shoreline processes for the next 200 years, priority was given to parcels that deliver sediment now (First Row parcels) versus later (Second Row parcels).

Table 1: Geophysical Criteria

	Geophysical Criteria			
Criterion Name	**First Row**	**Proximity Index**	**Erosion Rate Index**	**Bluff Height**
Criterion Code	**F**	**P**	**E**	**H**
Criterion Description	First Row grants a single point to all parcels that border the shoreline (2014). All other parcels receive a zero.	The Proximity Index is the normalized inverse of each parcel's distance from the base of the Spit. Closest parcel = 1, farthest parcel = 0.02.	E is the normalized average annual reach erosion rate, based on the Tribe's measured bluff recession rates from historic aerial photographs.	High bluffs (170 feet and higher in elevation) receive 0.015 point. Bluffs lower than 170 feet receive a zero.

The second elemental factor influencing sediment delivery to the beach is bluff erosion rate. In the Dungeness Drift Cell, site-specific bluff erosion rates can be extremely variable (0 to 17 feet per year) from year to year. However, relatively smooth stretches of shoreline indicate that erosion rates within reaches tend to be uniform over long periods of time. Otherwise the shoreline would be extremely jagged. Using information from the Tribe's erosion rate study, mean annual erosion rates for entire reaches were estimated. Reaches received an erosion rate index based upon their estimated mean annual erosion rate. Each parcel within a reach then received that same erosion rate index.

Table 2: Bluff Erosion Rates

Drift Cell Mile	Erosion Rate (feet per year)	Reach
5.94 to 8.60	1.25	Voice of America to Tradewinds Lane
8.60 to 10.31	0.75	Tradewinds Lane to West Gehrke Road
10.31 to 10.77	0.15	West Gehrke Road to Siebert Creek
10.77 to 13.61	0.7	Siebert Creek to Buchanan Drive

Bluff height determines the quantity of sediment delivered to the beach for any given amount of bluff recession. Throughout the easternmost 6.15 miles of bluff (DCM 5.1 to 11.25), the bluff height averages approximately 112 feet and ranges from about 90 to 144 feet (Figure 13). The undulation of these bluff heights does not appear to warrant discriminating between parcels due to their bluff height. Within

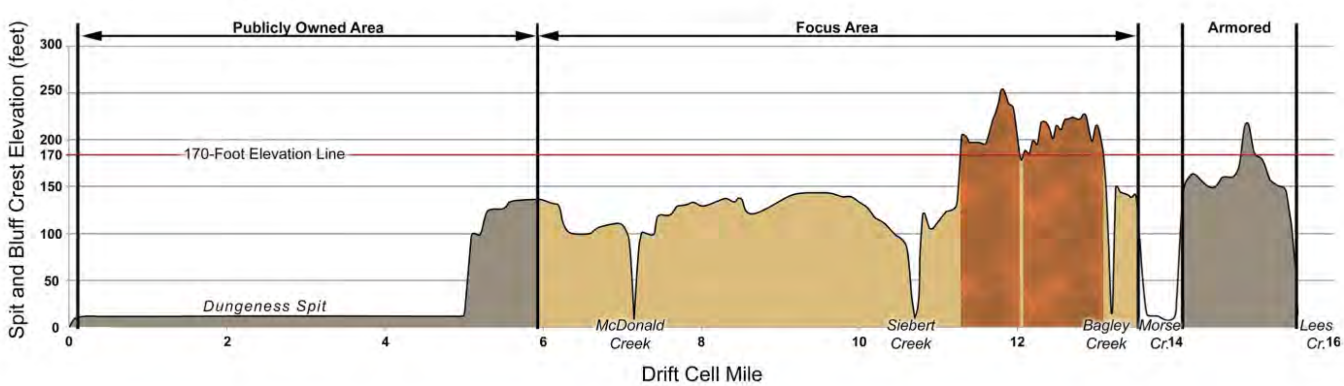


Figure 13: Bluff Elevation vs. Drift Cell Mile. Bluff Height = Bluff Elevation – 9 feet.

"The Bluffs" development however, between DCM 11.25 and 11.3 the bluff suddenly jumps to heights averaging about 203 feet and in one location exceeds 240 feet. These relatively greater heights extend to the Bagley Creek ravine at DCM 13.1. To address the juxtaposition of such dramatically divergent bluff heights within "The Bluffs", we segregated the parcels based on their bluff crest elevations being higher or lower than 170 feet. (The Dungeness Drift Cell bluffs originate at a toe-elevation of approximately 9 feet. Hence, bluff height equals bluff crest elevation minus 9 feet). Parcels with bluff crest elevations exceeding 170 feet receive 0.015 added to their prioritization score. Application of this scoring criterion elevates the scores of the highest bluff parcels above those of nearby, down-drift lower bluff parcels, especially within The Bluffs. The effect of bluff height criterion on the ordering of first-row parcels extends only to the eastern side of Green Point at DCM 10.3.

Delivery to the Spit:

Once bluff sediment has reached the beach, it is subject to wind, wave, and tidal forces that move it predominately eastwards. As sediment moves along, a percentage drifts offshore and out of the drift cell. This percentage is thought to be a function of the distance between the source and the Spit. Additionally, certain features along the way, such as Green Point, may deflect a larger percentage offshore. Thus, sediment delivered to the beach closer to the Spit is more likely to reach the Spit as contrasted with sediment that lands on a beach farther west from the Spit. Therefore a criterion was developed that measured the planer distance between the Spit and each parcel. This criterion is labeled "Proximity Index".

Sediment delivery prioritization score:

Combining the criteria for Proximity, Erosion Rate, Front Row, and Bluff Height into a single prioritization score involved adding 2.25 times the Proximity Index (P) value to 2.25 times the Erosion Rate (E) plus the Front Row (F) and Bluff Height (H) values (see equation below).

$$Score = 2.25(P + E) + F + H$$

The proximity of a parcel to the Spit and the average erosion rate of its reach are 2.25 times more important than the parcel being in the front row at the beginning of the 200-year planning period and

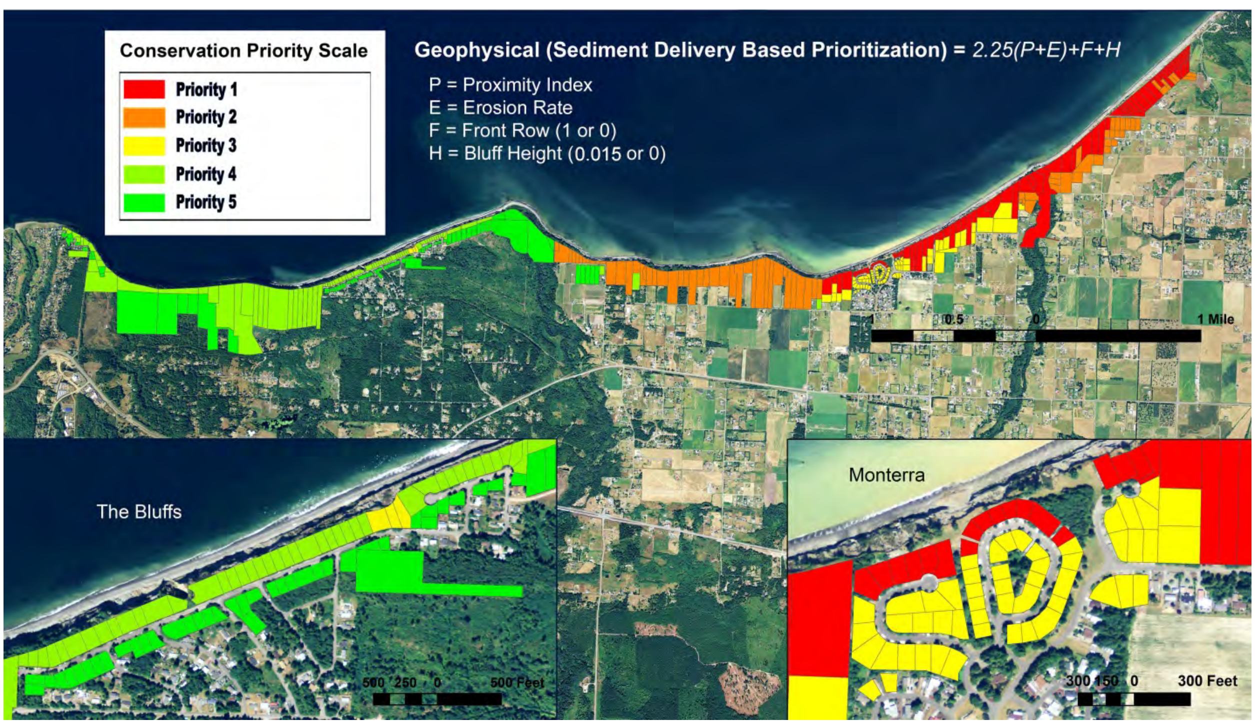


Figure 14: Sediment Delivery Prioritization- Each parcel is scored based on 2.25 times their proximity and erosion potential values plus one for front row parcels and 0.015 where bluff elevation exceeds 170 feet.

bluff height. Regardless, front row parcels are a higher priority for conservation than adjacent second row parcels.

For ease of evaluation, the final scores are converted to a familiar 0-10 scale with the highest ranking (most geophysically important parcel) receiving a score of 10.

Figure 14 is a graphic representation of the geophysical (sediment delivery) prioritization. Parcels with the greatest potential to deliver sediment to the Dungeness Spit are shown in Red and should be the focus of early conservation efforts. Green parcels are areas where later efforts will be focused. Note that the graphic divides the data into quantiles based on their scores. Once an organization is ready to begin implementing this conservation plan, the actual parcel scores may be more meaningful than the colored map image. Final scores for each parcel ranked from highest score to lowest can be found in Appendix A. Appendix B has the rankings ordered by drift cell mile while Appendix C has the rankings in order by parcel number.

Implementation Criteria

Geophysical prioritization is a powerful tool for drift cell conservation, yet it cannot operate independently of economic factors, organizational priorities, and landowner willingness. Landowner willingness (willingness to sell fee-simple or conservation easement or willingness to cooperate with the conservation measure) is likely the most important implementation criterion.

Table 3: Implementation Criteria list, codes, and descriptions.

	Implementation Criteria								
Criterion Name	**Parcel Geometry**	**Size Index**	**Opportunity Index**	**Hazard Index**	**Relocation Index**	**Immediacy of Threat**	**Length of Shoreline**	**Cost Effectiveness**	**Non Relocation Index**
Criterion Code	**G**	**S**	**O**	**HI**	**R**	**I**	**L**	**C**	**nR**
Criterion Description	Ratio of area (acres) inside the 200-year erosion band to the total acres on the top of the bluff	Acres of contiguous property owned by a single entity. Normalized by dividing each value by the largest value.	Assumes that conservation measures will be easier to implement on undeveloped parcels. Undeveloped parcels receive a score of 1, while developed parcels receive 0	Years to Contact is sorted into categories to produce four Hazard Indexes: 1.0, 0.5, 0.25, and 0. Parcels receiving a score of 1.0 have less than 10 Years to Contact.	Parcels with a residential structure that can be relocated outside the 100-year erosion band receive 1 point. All other parcels receive 0.	A combination of hazard index, ability to relocate structures, and structure density. Assumes that heavily developed areas are the most likely to be armored.	Length in feet of the bluff crest. Normalized by dividing the value by the highest value.	The property's monetary value divided by shoreline length, then normalized.	This is the opposite of Relocation Index. Should not be combined with Relocation Index.

Year by year, day by day, or even minute by minute landowner willingness can change, so this important factor could not be included in our analysis. To address the differing priorities among implementing organizations, the various conservation mechanisms, grant requirements, and some of the human aspects of the conservation effort, the stake holders developed a number of implementation criteria.

The following implementation criteria are designed to have values ranging from 0 to 1.They can be added and used with a subset of parcels (i.e. the highest ranking parcels from the Geophysical Prioritization) or combined with the geophysical criteria to score all the parcels. The resulting scores will rank parcels where the highest total score is the most suitable parcel for implementing the conservation measure, assuming landowner willingness. The implementation criteria are listed and define in Table 3.

Parcel Geometry:

Parcels along the Dungeness Drift Cell come in various dimensions and shapes. Most are rectangular, often with the narrow side abutting the shoreline. The Parcel Geometry criterion was developed for cases where an organization is seeking to maximize the amount of land within the 200 year erosion band that could be conserved with one landowner through the use of fee-simple land purchases or conservation easements. Parcel Geometry is the parcel's acreage within the 200 year erosion band divided by the total upland parcel area (*adjusted parcel area* - does not including the bluff face or any tidelands). Thus, where the entire upland area lies within the 200-year erosion band, Parcel Geometry equals 1. Properties containing land outside of the 200-year erosion band will have parcel geometry indices less than 1. Note: at the time of this analysis, parcel boundaries available to the Tribe are rough

Figure 15: Before and after example of Adjusted Parcel Acres. Adjusted Parcel Acres includes only area landward of the bluff crest. Adjusted Parcel Acres are for planning purposes only.

in many ways. Many are not based on surveys and boundaries are not regularly updated. As the bluff erodes and the shoreline migrates landward, many of the parcels lose acreage. This loss of land is not reflected in the parcel dataset. Most parcels reflect the shoreline at the time the land division was recorded or the shoreline location when the parcel was created. Therefore, adjusted parcel area includes only the area located inland from the bluff crest, so that older or poorly mapped parcels do not receive an improper score.

Size Index:

Using the adjusted parcel area and ownership information, Size Index is created by combining all the contiguous parcels owned by a single owner or a single ownership group. Ownership groups can be married couples, trusts, or even corporations. There are many family trusts with holdings along the drift cell. This criterion assumes that it will be easier and possibly cheaper to conserve more property when working with larger parcels or blocks of parcel under a single ownership then conserving many smaller parcels under the control of numerous owners.

Opportunity Index:

This criterion gives a single point to properties that are undeveloped, as of early 2014. It assumes that conservation measures will be easier and possibly cheaper to undertake on undeveloped land as contrasted with developed parcels, and that, according to landscape ecology principles, it's generally better to conserve a larger area of land.

Years to Contact and Hazard Index:

Each residential and commercial building within the focus area was assessed for the number of years remaining until the building will be endangered by bluff erosion. This assessment was expressed as *Years to Contact*. Years to Contact is estimated by dividing the distance between the bluff crest and a

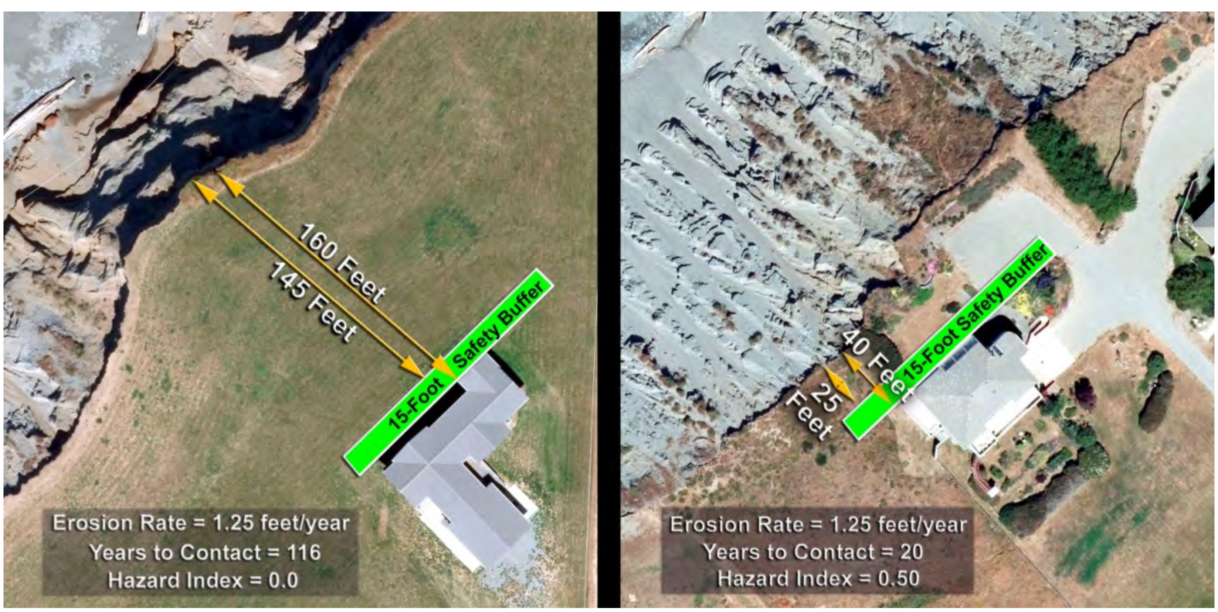


Figure 16: Examples of distance from bluff edge to structure.

point 15 feet in front of the structure (safety buffer) by the erosion rate in that area. Fifteen feet was established as a safety buffer because once the bluff crest erodes to within 15 feet, a single erosional event could cause the house to fall off the bluff. In several cases landowners have relocated residences before the bluff crest has eroded within 15 feet. Parcels with low Years to Contacts values are a higher priority for addressing with conservation measures.

Table 4: Analysis of Years to Contact

Years to Contact Categories (2012)	*Hazard Index* Score (2012)	Number of Parcels (2012)
<10	1	7
>10 to 40	0.5	23*
>40 to 100	0.25	68
>100	0	168
No Structure	0	117
Total Number of Parcels *2 were moved in 2014		382

All the prioritization criteria are designed to produce maximum values of one. Therefore in the case of Years to Contact, the values were sorted into categories to produce four Hazard Indexes: 1.0, 0.5, 0.25, and 0. A Hazard Index of one indicates the presence of a residence or commercial building with a Years to Contact value of 10 or less, while a Hazard Index of zero means that the structure has a Years to Contact value greater than 100 (Table 4).

Example calculation of Years to Contact and Hazard Index (Figure 15): Fifteen feet (width of the Safety Buffer) subtracted from 160 feet (distance of the house to the bluff edge) equals 145 feet. Dividing 145 feet by the erosion rate of 1 foot per year yields a Years to Contact value of 145 years. If on average, the erosion rate remains 1 foot per year, in 145 years this house will be 15 feet from the bluff crest. Had the structure not already been moved, it would be imperative that the house be moved back from the edge or be dismantled.

Relocation Index:

The ability to relocate a structure landward from the bluff crest (move it farther from harms-way) may be a key component of a conservation measure or strategy. Moving structures back from the bluff crest is a time proven and effective strategy for dealing with coastal erosion. Although moving a structure any distance provides some benefit we only considered cases where the parcel contains sufficient area to relocate the structure outside the 100-year erosion band. Relocation Index adds a single point to any structure that can be relocated onto the same parcel or a neighboring parcel owned by the same owner. This determination was done by visual interpretation from the 2013 air photographs in the GIS. Field verification and landowner willingness would still be required.

Immediacy of Threat:

Immediacy of Threat combines a structure's hazard index, the lack of room for structure relocation, and neighborhood development density into a single categorical criterion that assesses the likelihood that a landowner would attempt to slow bluff erosion through bluff modification or armoring. It is assumed that fear and financial ability are the primary factors that would lead a landowner to attempt to armor a high bluff property. While we are unable to measure fear or financial ability, structures with a low Years to Contact (high Hazard Index) will create fear for the owner. Fear may turn to desperation, especially where the landowner does not own sufficient property to move the structure back from the bluff.

Hence, structure owners with a low *Years to Contact* value and no relocation potential are likely to be the most fearful bluff property owners. It is also assumed that a group of property owners has a greater chance of mounting a high bluff armoring effort than a single landowner. The following decision matrix (Table 5) is used to determine the threat category (high to low) for any structure.

Table 5: Immediacy of Threat matrix. Each structure is placed into categories based on Years to Contact, neighborhood development concentration, and potential to relocate the structure. The categories are High, Medium-High, Medium, Low.

Years to Contact	Neighborhood Concentration	Relocation potential	Immediacy of Threat Category	Value
<50	Concentrated	No	High	1
50 to 200	Concentrated	No	Medium-High	0.5
<200	Concentrated	Yes	Medium	0.25
<200	Not Concentrated	N/A	Medium	0.25
>200	N/A	N/A	Low	0
No Structure	N/A	N/A	Low	0

Length of Shoreline:

Length of shoreline was recorded using the top of the bluff crest instead of the traditional ordinary high water or high tide line. This measurement simulates the value that would be generated by using a tape to measure the distance from boundary edge to boundary edge roughly along the bluff crest. The crest line is a consistently delineated and somewhat generalized line that was previously plotted and was easily used to generate length in feet in the GIS. Implementing a conservation measure that protects shorelines from future armoring would be enhanced by ranking parcels at least partly based on the length of shoreline that would be protected.

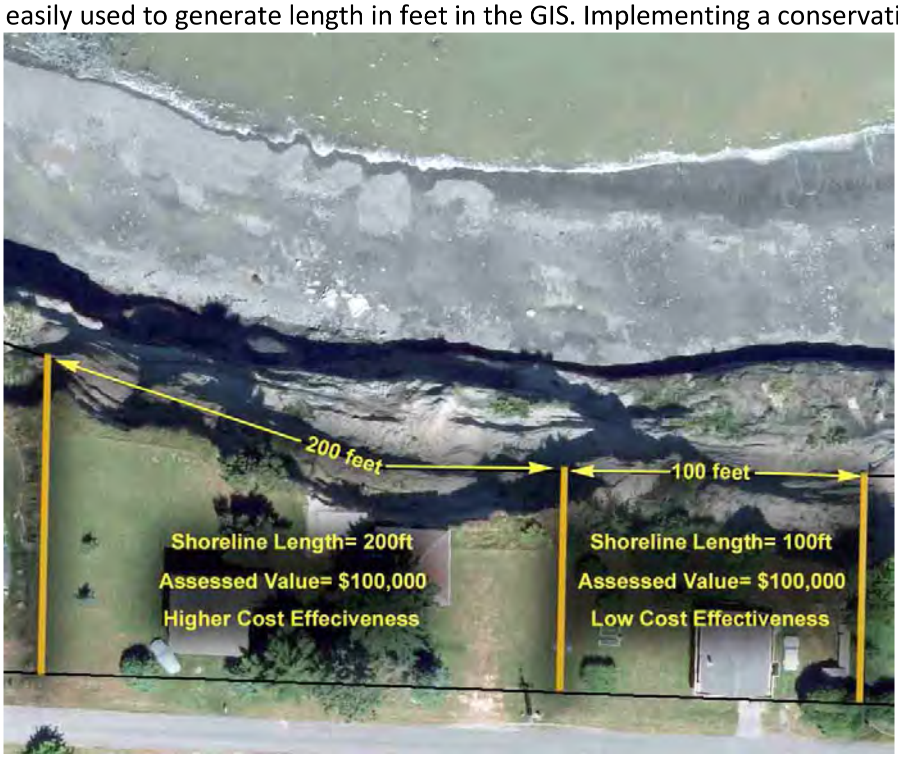


Figure 17: Cost Effectiveness Index- (Hypothetical example)- two parcels with the same assessed value where the parcel on the left has twice as much shoreline therefore has a higher Cost Effectiveness Index.

Cost Effectiveness Index:

Cost Effectiveness is calculated by dividing length of shoreline by the assessed value. Assessed values are determined by Clallam County and are very rough. Fair market value should be verified by a qualified property appraiser. Cost effectiveness assumes that the cost of the conservation measure will be related to the fair market value of the property and that cost effective implementation will be more likely on properties more feet of shoreline to be conserved per dollar spent. The index is created by normalizing the resulting data.

No-Relocation Index:

The No-Relocation Index is the opposite of the Relocation Index and should not be used in combination with the Relocation Index. Recognize that Immediacy of Threat Index includes relocation potential as one of its underlying metrics. For some implementation projects, it may be desirable to prioritize (or sort) parcels that contain a structure with no room to relocate it on the current owner's property.

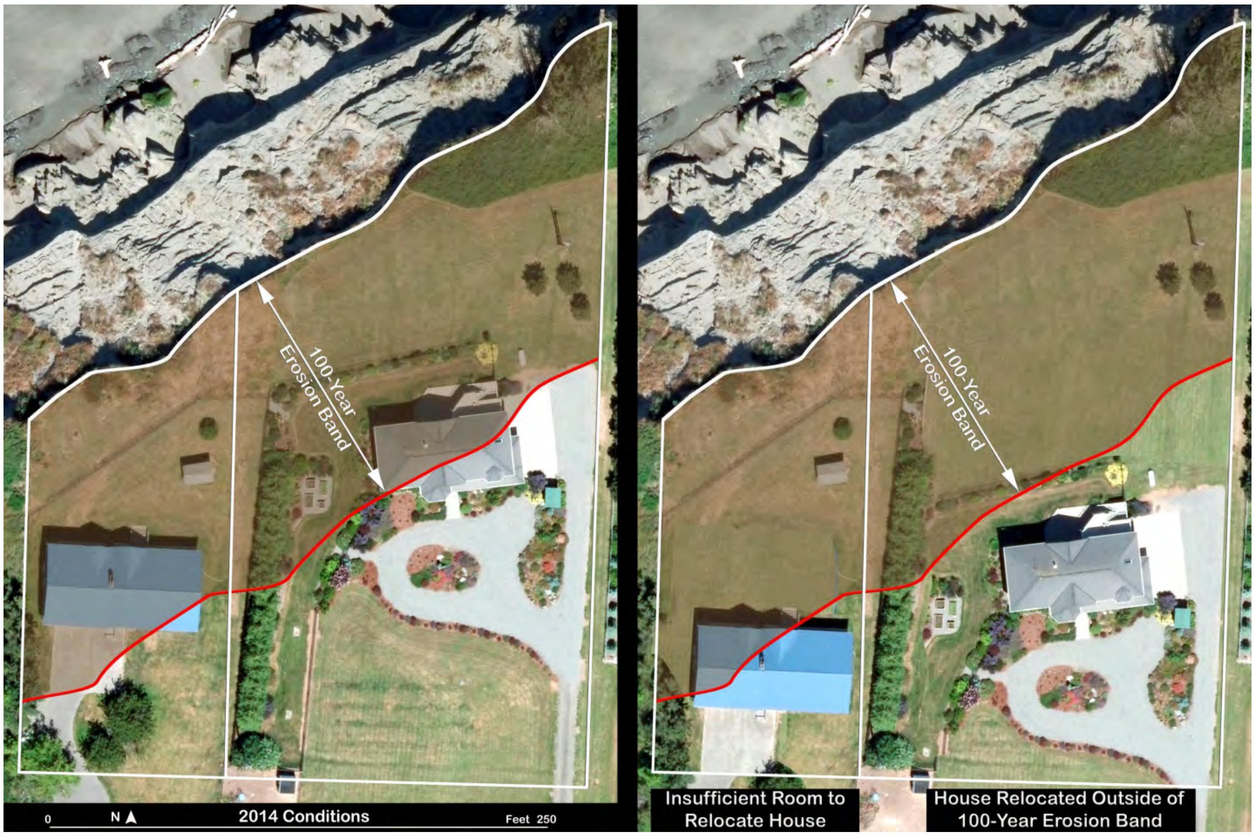


Figure 18: Examples of relocation potential.

Parcels with a structure and no relocation potential are given one point; parcels with no structure or with a structure that has relocation potential are given no points.

Implementation Prioritization

Combining implementation and geophysical criteria can be as simple as adding together the scores for each criteria that an organization wishes to use. However, this should often be an iterative process that uses the careful application of weightings to achieve the proper balance among criteria. The final outcome will be a list of potential candidates for a given conservation measure or incentive program. Without knowing which funding source or which incentive program may be available, implementation prioritizations can only be generated for several common conservation measures such as fee-simple acquisition, conservation easements, and restoration/relocation.

Fee-simple Acquisition:

Purchasing real property so that it may be managed as habitat or to conserve habitat and habitat forming processes is a common conservation mechanism. The Tribe has successfully purchased property using a number of funding sources to protect and restore floodplain habitats along local rivers and streams. When working to conserve the sediment supply for the Dungeness Spit purchasing parcels may preferred in some cases. For this prioritization, the geophysical $2.25(P+E)+F+H$ results would most likely be combined with parcel geometry and cost effectiveness.

Traditional Conservation Easement:

Protecting valuable natural resources, such as fish and wildlife habitat, through the purchase of conservation easements is a staple of the North Olympic Land Trust. The Land Trust has previously conserved a number of larger parcels along the Dungeness Drift Cell based solely upon their habitat value, without considering the parcel's sediment delivery potential. The Land Trust generally limits their interest to parcels 15 acres and larger that have received high scores using their project selection criteria scoring system. Within the focus area only a few parcels of this size remain and they tend to rank quite low on the Geophysical Prioritization rankings. We urge the Land Trust to adopt a drift cell-specific rating system that recognizes that certain land parcels less than 15 acres in size provide sediment essential to the maintenance of major off-site priority habitats. These parcels, regardless of size, should be considered for conservation using traditional conservation easements. The Tribe has no history of purchasing or holding conservation easements and is most likely to serve as a stakeholder, collaborator, or partner in a drift cell conservation easement program. The following prioritization could be used to create a list of suitable target parcels for conservation easements.

Bluff-Face Conservation Easement:

This is a yet to be developed, specific type of conservation easement designed solely to purchase landowners' rights to armor their shoreline. Because it only addresses sediment supply conservation without otherwise encumbering a property, this is an especially appealing potential conservation tool and could be a very cost effective measure. Landowners would sell a conservation easement specific to the bluff face, which would prohibit shoreline armoring. No other property right would be affected, and property owners would retain full use of their land and structures until such time, possibly many generations in the future, that the property has eroded away.

Relocation or Removal of Structures:

Ever since development of bluff-top properties began in the Dungeness Drift Cell, property owners' primary methods of addressing hazard risks caused by bluff erosion have been to relocate and remove structures before they become gravely imperiled. Where assurance can be provided that natural erosion of the property will not be interfered with by the current or future owners, structure relocation/removal could likely be combined with another conservation mechanism, such as a traditional conservation easement, bluff edge conservation easement or fee-simple acquisition. Prioritization criteria for relocating or removing structures may include Relocation Index, Non-Relocation Index, Geophysical Score, Hazard Index, Immediacy of Threat, and Cost Effectiveness.

Conclusions and Conservation Strategy

Maintaining the health and natural structure of Dungeness Spit is a high priority for the Jamestown S'Klallam Tribe. To ensure conservation of this important cultural, recreational, and economic resource, the Tribe, along with stakeholders and partners, will undertake a long-term strategy to conserve both the sediment source and its delivery to Dungeness Spit.

Early conservation efforts will focus on the bluff system between Morse Creek and the Spit. Starting with parcels identified as Priority 1, landowner willingness will be assessed and funding will be sought to implemented conservation measures. In upcoming years, the Tribe will seek funding and partnerships to conserve as much of the sediment source as possible. These efforts may involve the use of multiple conservation tools including, but not limited to:

- Fee-simple purchases that result in conservation ownership.
- Incentives to landowners to relocate structures.
- The purchase of traditional conservation easements. Since it does not generally hold conservation easements, the Tribe will seek to collaborate with organizations more readily suited for this task such as the Land Trust, Washington Department of Fish and Wildlife (WDFW), and Clallam County. Once a willing partner is in place to hold easements, the Tribe will work to find funding for conservation easements that protect natural bluff erosion.

While this plan provides an essential starting place for conservation planning and action, the Tribe will continue to be engaged with stakeholders, scientists, and agency staffs to develop a better understanding of physical processes occurring within the Dungeness Drift Cell and to adaptively manage our efforts as new information becomes available.

Because this is a large effort and voluntary stewardship is complex, a collaborative multi-organizational effort is clearly required to complete this important work. New conservation tools are needed. Puget Sound wide efforts are underway to better understand what motivates shoreline owners and to develop educational tools to help increase the level of understanding of the importance of maintaining natural processes that ultimately create and maintain many of the shoreline features that attract people to this area.

Acknowledgements

The Tribe is grateful to the USEPA and NWIFC for their vision and support for drift cell conservation. The North Olympic Land Trust and Puget Sound Partnership helped advance the prioritization and move this effort forward. Thank you to all the stakeholders who provided feedback and thoughtful comments on early drafts.

Appendices

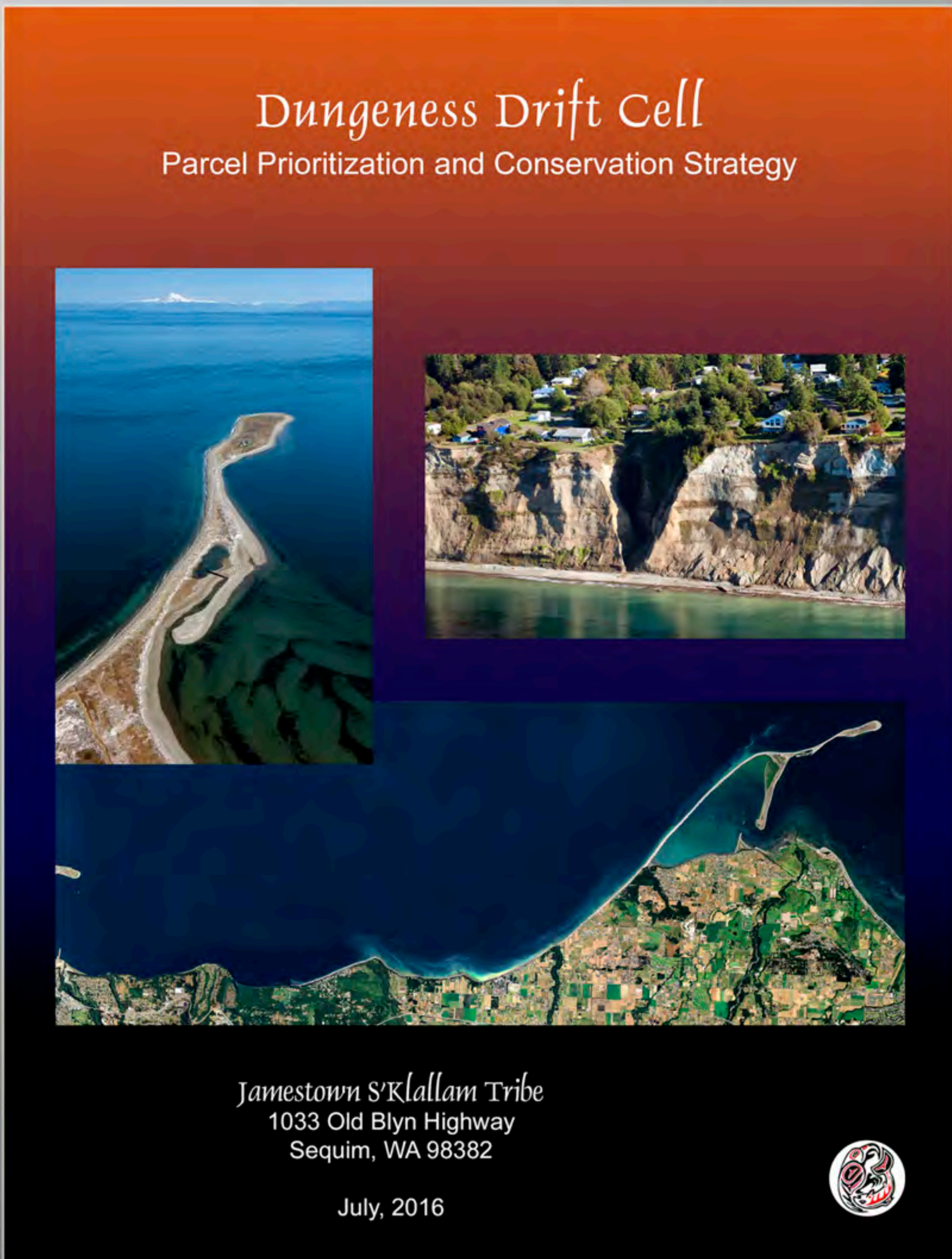
Appendices A, B, & C are sorted lists of land parcel prioritization scores. Each is sorted using a different column to provide multiple methods of finding a particular parcel, region, or score range. Given the dynamic ever-changing nature of the drift cell, drift cell mile hundredths are not in geologic terms a useful measure. However, for the purposes of these lists drift cell miles were expanded to include hundredths of a mile. This allowed for better sorting of parcels in Appendix B.

Appendix D is the North Olympic Land Trust's report, "Conservation Tools for the Dungeness Drift Cell and Land Trust Priorities". This document was developed in partnership with the Jamestown S'Klallam Tribe with a grant from the Puget Sound Acquisition and Restoration fund, through their Project Implementation and Development Award, grant #14-1028.

Appendix E is a set of 2014 orthophotos labeled with drift cell miles.

Appendix F is a set of 2013 oblique air photos labeled with drift cell miles.

Appendix G is the document, "Estimates of Feeder Bluff Recession Rates in the Dungeness Spit Drift Cell, Clallam County, Washington".



Appendix A

Parcels Prioritized by Geophysical Score

Appendix A: Parcels ranked by geophysical score.

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Geophysical Score (highest to lowest)	5.95	043133339030	AIDA ACRA KATTAN	NA	10.000000
	5.97	043133339020	AIDA ACRA KATTAN	NA	9.040743
	5.99	043133339010	AIDA ACRA KATTAN	NA	8.680114
	6.01	043133339150	AIDA ACRA KATTAN	NA	8.390113
	6.03	043133339140	AIDA ACRA KATTAN	NA	8.137895
	6.05	043133339130	AIDA ACRA KATTAN	NA	7.937934
	6.07	043133339070	AIDA ACRA KATTAN	NA	7.770302
	6.09	043133339060	AIDA ACRA KATTAN	NA	7.620957
	6.12	043133339050	AIDA ACRA KATTAN	NA	7.489237
	6.17	043133359060	THOMAS R MC COOL TTE	69	7.363308
	6.17	043133359050	DANIEL R AND LINDA S MASYS	46	7.247098
	6.21	043133359140	PRISCILLA K RAYMOND	74	7.154712
	6.19	043133359120	TROY AND STEPHANIE WARD	NA	7.151583
	6.26	043133359160	PAUL S THOMPSON TTE ET AL	NA	6.989232
	6.31	043133339235	GEOFFREY WELLS TTE ET AL	64	6.863141
	6.35	043133330440	GARY AND KRYSTYNA GORDON TTES	84	6.763149
	6.40	043133330430	DR TIMOTHY B NEWLAND	96	6.681442
	6.43	043133339220	BENJAMIN C AND CATHERINE N KWAN TTES	NA	6.614915
	6.45	043133339210	FRANK AND SHARON BALESTRERY	NA	6.579266
	6.47	043133359040	BARRY H KANTOWITZ	65	6.571524
	6.49	043133359030	CORBY SOMERVILLE AND J MARTIN	36	6.529110
	6.51	043133359020	THOMAS AND MARILYN SCHLOSSER TC	NA	6.511298
	6.59	043133359010	JULIUS V SAKAS	21	6.494050
	6.61	043004229260	ELEANOR SCHOEN AND C ENGVALL TTES	59	6.431600
	6.66	043005110100	AKE AND SIW ALMGREN	94	6.413124
	6.67	043005110200	SUZANNE M FLEMING	NA	6.383084
	6.80	043005110175	JAMES C LOESCH	115	6.350388
	6.88	043005149030	LARRY AND JAN LITTLE AND M ROOSSIN	53	6.311478
	6.96	043005140300	RONALD AND NATALIE SALOIS JTWROS	NA	6.280407
	6.99	043005139010	JAMES R RIGGINS TRUST	49	6.252769
	7.11	043005510370	MC DONNELL CRK RCH OWNERS ASSN	NA	6.219784
	7.26	043005130050	MARJORY D BARTEE	192	6.209259
	7.22	043005130100	L D CHARF TRUST	NA	6.194963
	7.27	043005310010	ALANNA AND JOHANNA AND NAOMI BARTEE	NA	6.180891
	7.32	043005310020	ALANNA AND JOHANNA AND NAOMI BARTEE	NA	6.170970
	7.40	043005310100	GEO BRALY AND KATHERINE M ROAT	88	6.155938
	7.57	043005310125	THOMAS D AND JOAN F FITZPATRICK JT	NA	6.138527
	7.61	043005329010	DAVID AND LISA MURPHY	81	6.131093
	7.64	043005320060	TERRANCE N AND CATHERINE J BENDOCK	114	6.126360
	6.02	043133339040	AIDA ACRA KATTAN	NA	6.126122
	7.67	043005329050	GLEN AND CAROL WILHELM TTES	102	6.122002
	7.69	043005329110	ROGER C AND JUDY K WAGNER JOINT REV LIV TRUST	NA	6.117083
	7.73	043005320030	ROBERT G HATLESTAD	207	6.112833

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Geophysical Score (highest to lowest)	7.77	043005329070	RICHARD L AND SHIMAKO BUCK	124	6.108461
	7.81	043005339050	PETER REITER AND JONDA ROURKE TR	59	6.103992
	7.87	043005320225	SCOTT C WOLT	47	6.099951
	7.89	043006419110	WILLIAM I KOENIG	122	6.097926
	7.92	043006419010	WILLIAM I KOENIG	NA	6.093569
	7.96	043006410250	WILLIAM I KOENIG	103	6.090584
	8.01	043006419070	KATHRYN E ELLIS	222	6.087392
	8.03	043006419060	PHILLIP G AND BONNIE L KUCHLER	208	6.085607
	8.08	043006419030	DON J BRADLEY	97	6.083928
	8.09	043006510030	PETER AND DAWN WESTON WEBB	43	6.079969
	8.12	043006510020	DAVID M HOLLY	52	6.078121
	8.14	043006510010	CECIL L BLACK TTE	45	6.077019
	8.15	043006410100	BOB HAYS	49	6.075879
	8.21	043006500050	SHERRY LEE STOUT	199	6.070308
	8.23	043006500057	MELVIN L HANSON	84	6.070155
	8.24	043006500060	SCOTT S AND LINDA J PAULSON	39	6.069571
	8.26	043006500065	EARL W MCDONALD	20	6.068702
	8.26	043006500070	ROGER AND VIRGINIA HUNTMAN	10	6.067548
	8.27	043006500075	JUDIE A RICH TTE	13	6.066628
	8.29	043006500080	J D ADAMS	34	6.065534
	8.31	043006500090	DAVID AND PATRICIA VANDERGRIEND	87	6.064809
	8.33	043007510140	PATRICK AND P A MORRISSEY	59	6.063487
	8.35	043007510130	ROY C AND JANIS FLANAGAN	62	6.062520
	8.36	043007510120	ARTHUR E SWARNICK	55	6.061487
	8.38	043007510110	ROBERT AND BARBARA HOUTZ	48	6.060585
	8.41	043007510100	DON AND PATRICIA MOFFETT	46	6.059594
	8.42	043007510090	THOMAS A AND TERESA M SCHMID	86	6.058275
	8.48	043007219080	MARION AND WANDA YANDELL	85	6.057885
	8.51	043007210050	BRIAN AND JANETH TOMLINSON	88	6.054522
	8.51	043007219110	JERRY E AND RONITA C FLACK	73	6.053000
	8.54	043007219010	WILLIAM T BARTLETT,JR.	38	6.051179
	6.06	043133339160	AIDA ACRA KATTAN	NA	5.924846
	6.12	043133339080	AIDA ACRA KATTAN	NA	5.703021
	6.05	043133339090	AIDA ACRA KATTAN	NA	5.524394
	6.15	043133359080	WALKER SURVIVORS TRUST	NA	5.434691
	6.09	043133339100	AIDA ACRA KATTAN	NA	5.387238
	6.17	043133359070	REBECCA S CORLEY	233	5.346200
	6.22	043133359130	JAMES AND BEVERLY CONE TTES	173	5.193641
	6.24	043133359150	BOTHELL REV FAMILY TRUST	NA	5.098915
	6.26	043133359170	BOTHELL REV FAMILY TRUST	53	5.096823
	6.48	043004229050	GEORGE S FRANCHINI	689	4.698646
	6.50	043004229100	WILLIAM AND SHARON CAMUSO TTES	496	4.684560
	6.52	043004229090	JOSHUA ARMSTRONG	462	4.670509

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Geophysical Score (highest to lowest)	6.55	043004229140	STEVEN AND SHARON ROBINSON	NA	4.656116
	6.57	043004229130	DAVID AND MARJORIE WOODCOCK	NA	4.640861
	6.59	043004229250	JOHN E DINIUS	152	4.627037
	6.60	043004229150	GARY AND SUSAN HENRICKSEN	556	4.605466
	6.62	043004229160	DAVID AND MARJORIE WOODCOCK	478	4.594195
	6.64	043004229240	JAMES AND KAREN FADDIS	NA	4.583113
	6.67	043004229230	ROBERT AND ANNE MCGONIGEL JTROS	NA	4.572486
	6.67	043004229020	GLENDA MCLAREN	546	4.558907
	6.70	043004229010	JACK L HOLT	439	4.548359
	6.74	043004229040	RITA AND DAVID WISE	588	4.529333
	6.82	043005149040	LARRY AND GAIL ST PETER	631	4.496612
	6.85	043005140200	ROBERT J AND JOYCE M FILIP TRUSTEES	579	4.482613
	6.87	043005149020	ROBERT J AND JOYCE M FILIP TRUSTEES	NA	4.480896
	6.98	043005149000	JAMES AND THERESA STOVER	652	4.435763
	7.02	043005140150	RAOUL AND MAUREEN SAID	NA	4.424084
	8.63	043007219220	JOHN AND JAMES FISKER ANDERSON	578	4.411567
	7.07	043005139020	IRIS I DUDLEY	232	4.411494
	8.66	043007219210	RAYMON AND GEORGIANNA SEKO	383	4.410362
	8.67	043007220020	ALLEN AND RACHEL VANNESS	NA	4.409234
	8.74	043007220010	PETER SAARI	943	4.407659
	8.75	043007220060	KUEST FAMILY TRUST	484	4.406101
	8.78	043007220050	KUEST FAMILY TRUST	434	4.405336
	8.81	043007220125	KUEST FAMILY TRUST	71	4.404724
	8.92	043007228020	DAVID AND EVELYN BROWN	180	4.403996
	7.08	043005139030	DOUGLAS B AND MERIKE NICHOLS	416	4.402574
	8.94	053012110000	GREEN SPRINGS ASPEN LLC	NA	4.402302
	8.97	053012110130	GREEN SPRINGS ASPEN LLC	NA	4.401704
	8.97	053012110135	DANIEL AND JANET ABBOTT	115	4.400873
	9.06	053012110145	DENNIS AND DIANE VENZON	72	4.398584
	9.12	053012110125	ROY G AND CHERIE L BROWN TTES	80	4.397517
	7.09	043005139040	MARK AND JACQUELYN WITTE	525	4.395265
	9.17	053012110100	EUGENE AND LINDA ANDERSON TTES	142	4.395241
	9.20	053012119010	STANTON AND CAROL CREASEY	185	4.393101
	9.23	053012120000	BARBARA C DRENNAN	289	4.392101
	9.27	053012128010	JESSE H BLAKE	344	4.389895
	9.33	053012129050	FLORENCE P HIGHTOWER TTE	116	4.387733
	9.39	053012129030	CARLTON W AND BERNIECE E CLEVELAND TTES	216	4.386565
	9.40	053012120125	SCOTT D AND GINGER L WIERZBANOWSKI	157	4.385284
	9.45	053012500100	MARJORY GRAUE	NA	4.383824
	9.48	053012500125	MARJORY GRAUE	NA	4.382785
	9.51	053012509450	PAUL D COOVER	134	4.381849
	9.64	053012500200	PACIFIC STAR INVESTMENTS LLC	182	4.379971
	9.67	053012500250	DW COLLIER CHARITABLE TRUST I AND W COLLIER FAM LLC	NA	4.378229

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Geophysical Score (highest to lowest)	9.67	053012500275	DOMAINE MADELEINE LLC	107	4.377649
	9.71	053012509250	CAPPY AND BETH ROTHMAN TTES	98	4.376809
	9.75	053012509240	CAPPY AND BETH ROTHMAN TTES	88	4.376654
	9.78	053012509480	ANN WEINER	46	4.376007
	9.80	053012500300	MARY ANN HUDSON	6	4.374995
	9.90	053012500400	HEARST AND JERRI COEN REV LIVING TRUST	84	4.373916
	9.97	053001300400	OTTO JR AND BILLIE STOEPLER	50	4.372440
	10.00	053002400050	MICHAEL J SCOTT	3	4.370927
	10.01	053002409010	PAUL ONOPIUK	49	4.370012
	10.06	053002409020	SMITH FAMILY TRUST	51	4.369479
	10.07	053002400200	WALTER CAMERON AND SANDRA WALKER	79	4.368632
	10.10	053002400300	AMY J GREENLIEF	67	4.368224
	10.11	053002400150	GERHARD L AND MARY M HELLER	96	4.367875
	10.13	053002400400	GARY AND JUDY GOODWIN	NA	4.367505
	10.15	053002439000	R G AND MARGERY CROOK FAM TRUST	185	4.367188
	10.20	053002449000	TREADWELL FAMILY TRUST	237	4.366783
	10.23	053002400000	MORY AND BARBARA HOUSHMAND	333	4.366455
	7.27	043005420150	MARJORY D BARTEE	NA	4.365595
	10.30	053002439010	BRIAN AND JANETH TOMLINSON	79	4.365335
	7.30	043005420100	PAUL AND MARGARET PINZA	787	4.359617
	7.30	043005420160	MARJORY D BARTEE	288	4.357312
	7.31	043005429000	MARJORY D BARTEE	NA	4.351790
	7.33	043005429020	MARJORY D BARTEE	419	4.349836
	7.35	043005429010	MARJORY D BARTEE	502	4.346812
	7.44	043005310030	ALANNA AND JOHANNA AND NAOMI BARTEE	365	4.339534
	7.52	043005310040	ALANNA AND JOHANNA AND NAOMI BARTEE	NA	4.332097
	7.60	043005310140	THOMAS D AND JOAN F FITZPATRICK JT	324	4.317635
	7.65	043005329020	ROBERT AND LANI DRAKE	NA	4.305058
	7.68	043005329030	ARTHUR J BUHRER	NA	4.299966
	7.73	043005329040	THOMAS AND PENE SCHMOLKE	451	4.296973
	7.76	043005329100	ROGER C AND JUDY K WAGNER JOINT REV LIV TRUST	378	4.292899
	7.84	043005329060	RICHARD L AND SHIMAKO BUCK	NA	4.285735
	7.91	043005339010	OSCAR G AND SUSAN A SANCHEZ TTE	NA	4.284814
	7.87	043005339060	PETER REITER AND JONDA ROURKE TR	NA	4.281301
	7.89	043005339070	SCOTT C WOLT	NA	4.279411
	7.91	043005330040	MICHELE ERICKSON	670	4.277067
	7.95	043006419100	WILLIAM I KOENIG	NA	4.273595
	7.97	043006419090	WILLIAM I KOENIG	NA	4.270881
	8.00	043006419020	WILLIAM I KOENIG	NA	4.268240
	8.11	043006419040	DON J BRADLEY	NA	4.261590
	8.12	043006510040	PETER GRASSI AND SHIRLEY MCFADDEN	206	4.259734
	8.13	043006419050	DON J BRADLEY	NA	4.259684
	8.14	043006510050	GENEVA M KYDLAND TTE	274	4.258006

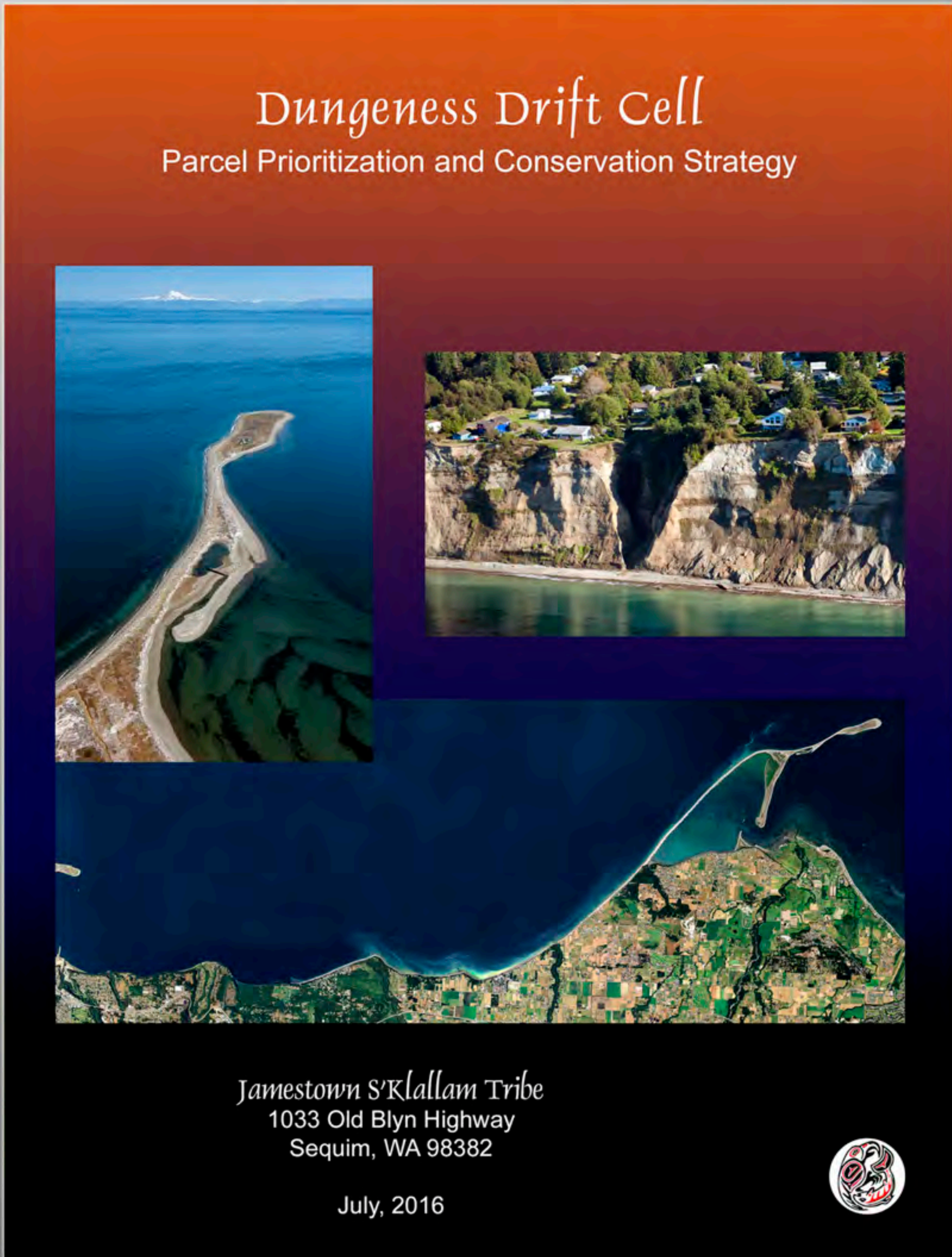
	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Geophysical Score (highest to lowest)	8.14	043006510100	PAUL D AND CAROL A JENNINGS TTES	431	4.257076
	8.15	043006510060	ELNA R CARROLL FAMILY TRUST	225	4.257056
	8.15	043006510090	NANCY L AVERY AND ELEANOR NAUMAN	388	4.256251
	8.15	043006510070	SHIRLEY RATE	250	4.256070
	8.17	043006510080	KRISTINE AND ALAN JOHNSON	331	4.255396
	8.16	043006510120	CHARLES A AND ETHEL BENTLEY TRUST	520	4.254401
	8.18	043006510130	KATHI L GUNN	514	4.253575
	8.19	043006510140	LINDA L FRAZER	490	4.252507
	8.20	043006500045	KATHLEEN E TRAINOR	272	4.252126
	8.22	043006500040	JOSEPH AND DORIS CAUGHEY ET AL	324	4.251880
	8.23	043006500035	JOHN R AND SUSAN L WILLETTE	374	4.250708
	8.24	043006500150	JACK AND NANCY METCALFE	218	4.249894
	8.25	043006500145	JUNE H MILES	296	4.249829
	8.26	043006500155	DONALD L HECKATHORN TTE	147	4.249677
	8.25	043006500025	STEVEN AND CINDY RUNNION	469	4.248951
	8.25	043006500140	STEVEN AND ROBIN MASTERS	328	4.248851
	8.26	043006500160	KENT BOSTER AND FRED AND KATHLEEN SWENSON JTWRS	145	4.248802
	8.26	043006500135	IAN D MACKENZIE	369	4.248054
	8.25	043006500015	ORUM D AND AGNES E MEDSKER	525	4.248047
	8.28	043006500165	JOHN D AND MAUREEN SEWELL	157	4.247799
	8.29	043006500170	GERTRUD J WRIGHT-TRUST	239	4.247380
	8.29	043006500175	CARL AND SUSAN KAISER	294	4.246933
	8.30	043006500180	JENI AND DELON TURNER	363	4.246477
	8.28	043006500010	WALTER J STAPISH	533	4.246213
	8.32	043006500100	ALLEN/JULIE W TERRELL	144	4.246171
	8.32	043006500105	PAMELA J HANNA	213	4.245698
	8.30	043006500005	LAVINA BAUMANN	508	4.245583
	8.32	043006500110	LAURNA KING AND RUTH LINGER JT	269	4.245240
	8.32	043006500115	ROBERT J AND JANICE M ORR	332	4.244832
	8.33	043006500120	WILIIAM A AND HELEN A WICK	382	4.244404
	8.34	043007510150	PEARLE L BRADLEY	229	4.244190
	8.33	043006500125	DAL H KILMER	446	4.244063
	8.34	043007510210	STEVEN B AND KATHY TUCKER	405	4.243287
	8.36	043007510160	JOHN AND MARY ANN HARTMAN	245	4.242898
	8.36	043007510200	ELAINE V ODER	356	4.242721
	8.39	043007510170	FELICIAN AND R D VADON	215	4.241873
	8.38	043007510190	STEVE AND CLARA LAKATOS	319	4.241710
	8.36	043007510010	GENE L ROBINSON	545	4.241660
	8.37	043007510020	VERNON AND RUTH I MEADOWS	473	4.241206
	8.40	043007510180	BETTY LOU LONG	273	4.240659
	8.39	043007510030	LAWRENCE P AND KLARA MORGAN	438	4.240396
	8.40	043007510040	MARJORIE SMOKE TTE	443	4.239634
	8.43	043007510080	SANDRA P KELLO ET AL	203	4.239170

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Geophysical Score (highest to lowest)	8.41	043007510050	R KEITH PARDUE	416	4.238849
	8.44	043007510070	ROBERT AND KAREN AGEE	284	4.238541
	8.42	043007510060	JOHN AND EMILY LUENOW	354	4.238418
	8.43	043007500500	JOHN F AND JANET L CASSIO	509	4.237737
	8.44	043007500600	DANIEL LIVRAMENTO	512	4.236427
	8.51	043007219090	BRENT L BERRY	512	4.235395
	8.55	043007219120	DONALD AND JOANNE MORRISON	220	4.232753
	8.54	043007219070	ROBIN AND CAROL LEE MOSES	519	4.232079
	8.57	043007219060	JEFFREY P WHITE	437	4.230870
	8.60	043007219020	KENNETH AND CHIQUITA HIYOSHIDA	424	4.229305
	11.28	053010560136	DEREK REED TTE	144	4.213250
	11.29	053010560134	KEITH AND SANDRA L PATTISON TTES	66	4.212981
	11.33	053010560130	WILLIAM E AND JULIA ANN N GOTTHOLD TTES	14	4.212754
	11.33	053010560128	KELLY PATRICK BURKE	15	4.212301
	11.34	053010560126	STEVEN P BRIDGE	27	4.212099
	11.37	053010560124	ROBERT AND ROBIN BORDONARO	66	4.211892
	11.38	053010560122	ROBERT E AND E M BROWN	62	4.211672
	11.40	053010560120	TONY I AND CONNIE J LITTLE	10	4.211473
	11.41	053010560118	TONY I AND CONNIE J LITTLE	NA	4.211286
	11.44	053010560115	MONTY AND SHERRY WEBB	67	4.211074
	11.45	053010560112	MONTY AND SHERRY WEBB	NA	4.210641
	11.47	053010560110	JERRY A SCHNATTERLY	60	4.210437
	11.48	053010560108	JERRY A SCHNATTERLY	37	4.210225
	11.49	053010560106	KAREN STEINMAUS	NA	4.210019
	11.51	053010560104	KAREN STEINMAUS	83	4.209823
	11.52	053010560102	MILTON AND FAYRENE KENOYER	NA	4.209617
	11.54	053010560100	EUGENE AND JEANNE BLAETTLER	73	4.209421
	11.55	053010550140	ROBERT S BROWN	NA	4.209212
	11.56	053010550138	JACK LEON LA FORGE	109	4.209002
	11.57	053010550135	DONALD HILYARD AND G S LALONDE	90	4.208809
	11.65	053010550130	DONALD HILYARD AND G S LALONDE	NA	4.208055
	11.65	053010550128	ANDREW M AND JEANETTA J JOHNSON	101	4.207708
	11.69	053010550126	ROSS L CANNING	68	4.207146
	11.70	053010550122	JOSEPH AND PAULINE PRETI TTES	81	4.206965
	11.73	053010550120	GUENTHER HERZ TTE	68	4.206623
	11.76	053010570020	PHILIP K URATA	45	4.206442
	11.79	053010570010	CHRISTOPHER D SAARI	19	4.206167
	11.81	053010550110	CRAIG SMITH AND MARY HEFFERMAN	132	4.205883
	11.83	053010550108	LARRY D DOUGLAS	106	4.205517
	11.84	053010550106	FERYDUN AND LAGHAIEH REZVANI TTE	NA	4.205336
	11.84	053010550104	PETER A LAVELLE	87	4.205149
	11.87	053010550102	SUE ELAINE RAINEY	33	4.204989
	11.88	053010550100	EDWIN C MURPHY	15	4.204799

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Geophysical Score (highest to lowest)	11.91	053010230140	DON AND CHARLENE HENSLEE	NA	4.204609
	11.94	053010230130	DON AND CHARLENE HENSLEE	NA	4.204221
	11.98	053010230120	JOHN WARRICK AND RUTH JENKINS TTES	NA	4.203845
	12.00	053010230110	JOHN WARRICK AND RUTH JENKINS TTES	68	4.203471
	12.03	053010230105	JOHN WARRICK AND RUTH JENKINS TTES	NA	4.203118
	12.04	053010230090	MICHAEL T AND D M OLSON	246	4.202780
	12.09	053010230080	MICHAEL AND DINA OLSON	NA	4.202441
	12.12	053009140070	JOHN WARRICK AND RUTH JENKINS TTES	153	4.202101
	12.21	053009140030	GEORGE E AND CATHERINE M LANHAM	91	4.200826
	12.24	053009140020	JUDY L PALLAGI	54	4.200538
	12.27	053009140010	SYLVIA FEDER	NA	4.200249
	12.35	053009140120	JEANINE CARDIFF	209	4.199954
	12.38	053009140100	JOHN WARRICK AND RUTH JENKINS TTES	NA	4.199300
	12.52	053009120252	NANCY J MCLAUGHLIN TTE	333	4.198720
	12.57	053009120270	DAVID M THOMPSON	NA	4.197748
	12.59	053009120350	JESSIE A AND SANDY L HYCHE	NA	4.197098
	12.65	053009210000	BURT W REID	NA	4.196536
	10.87	053002309045	WHITEGIVER-SCHMITZ	NA	4.194535
	13.14	053009221000	GEORGE C RAINS SR LIVING TRST	NA	4.194312
	10.95	053002309005	JOHN A SCHMITZ TTE	NA	4.192691
	13.17	053008110000	GEORGE C RAINS SR LIVING TRST	NA	4.192373
	10.98	053002309085	RICHARD L ADAM	NA	4.190773
	11.06	053010560180	M DAVIS ESTATE	15	4.189244
	11.09	053010560178	NATALIE SPIEGEL	30	4.189103
	11.10	053010560176	JAMES AND PAMELA HARDIE	11	4.188826
	11.12	053010560174	JOHN AND VICKI L PASALICH	50	4.188471
	11.14	053010560172	DAVID AND CECILIA COLBY	69	4.188228
	11.15	053010560170	GARY E SJOROOS	45	4.187997
	11.16	053010560168	CLAIRE J AND BONNIE C GILSTAD TTES	32	4.187749
	11.17	053010560166	RICHARD A AND PAULINE J CALLIS	49	4.187523
	11.19	053010560164	RAYMOND N AND C BRAUN	26	4.187304
	11.20	053010560162	STEPHEN D MULDER AND BETH E MULDER CO-TTE	34	4.187059
	11.22	053010560159	FEDERAL HOME LOAN MORT CORP	6	4.186835
	11.25	053010560155	RICHARD C AND MILDRED D JOHNSEN JOINT LIVING TRUST	84	4.186435
	13.18	053008510100	GEORGE C RAINS SR LIVING TRST	39	4.164928
	13.26	053008510020	DAVID K AND MARIA S TEBOW	114	4.164653
	13.39	053008510030	RICHARD J SCHOENFELDT	1	4.164342
	13.42	053005510065	HALL SURVIVORS TRUST	NA	4.164086
	13.45	053005510070	ROBERTA J FISHER TTE	184	4.163848
	13.54	053005400000	JOHN AND NINA PURCELL TTES	NA	4.163729
	13.48	053005510085	DAVID J SALVETER	192	4.163725
	13.57	053005500050	CECIL C WHITE	26	4.163363
	13.59	053005500045	STEVE AND MIRJA WILSON	7	4.163190

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Geophysical Score (highest to lowest)	13.61	053005500040	JOSEPH T WANNER	1	4.163083
	8.63	043007219240	ROBERT AND LINDA ADAMS TRUST	952	2.589665
	9.72	053012509470	ANN WEINER	NA	2.557089
	10.00	053011119000	HENRY AND SANDRA LEIS FAMILY REVOCABLE LIVING TRUST	NA	2.552284
	10.01	053011500000	BRIAN SCOTT AND HEATHER JANE STAMON	219	2.551578
	10.03	053011500100	ROBERT G ELLIS	253	2.550935
	10.05	053011500200	DAVID B CANTON AND NANCY L MAYER	432	2.550292
	10.07	053011500300	GARY R SWENSON	362	2.549651
	10.09	053011500400	RICHARD T AND DOROTHY A GRACE	580	2.549013
	10.32	053002400360	EVELYN M PLANT TTE	NA	2.401171
	10.44	053002400350	EVELYN M PLANT TTE	NA	2.400664
	10.65	053002300000	EVELYN M PLANT TTE	125	2.398721
	11.36	053010110000	FRED WAGNER	NA	2.397157
	10.70	053002300050	EVELYN M PLANT TTE	NA	2.396014
	11.25	053010560140	RICHARD V AND PAMELA J EHTEE LIVING TRUST	422	2.395664
	11.25	053010560138	JEFFREY A LITTELL	253	2.395353
	11.33	053010560244	TYLER J AND OLIVIA P AVERY	323	2.394453
	11.36	053010560246	ERICKSON LOGGING II LLC	NA	2.394188
	11.39	053010560249	JOHN M AND CHARMAYNE D HURLBUT	357	2.393677
	11.42	053010560348	TONY I AND CONNIE J LITTLE	NA	2.393082
	11.43	053010560346	THOMAS J LAROSA	314	2.392815
	11.46	053010560342	IRENE R SCHAFFNER	318	2.392605
	11.48	053010560340	LUIGI L NICOLOSO	313	2.392182
	11.49	053010560338	GLEN KOBATA	NA	2.391972
	11.50	053010560336	DONALD KRAUS	338	2.391769
	11.54	053010560334	LARRY D DOUGLAS	356	2.391395
	11.56	053010550314	JOHN AND SANDRA STEPHENS	666	2.391301
	11.55	053010550312	GLEN KOBATA	NA	2.391076
	11.59	053010550254	KIMI HOYLE	NA	2.390585
	11.59	053010550252	MICHAEL AND ANN BUELL REVOCABLE TRUST	398	2.390314
	11.61	053010550250	CHARLES E LEACH AND B A POZNANOVIC	NA	2.390100
	11.62	053010550248	CHARLES E LEACH AND B A POZNANOVIC	316	2.389899
	11.64	053010550244	DONALD AND COLLEEN DALEY	320	2.389688
	11.68	053010550242	THOMAS AND SHARON FRITSCHLER	NA	2.389192
	11.69	053010550240	THOMAS AND SHARON FRITSCHLER	378	2.388928
	11.71	053010550238	EUGENE J AND JO CAVANAGH	372	2.388737
	11.72	053010550194	BARBARA K HORACEK TTE	309	2.388534
	11.77	053010550192	WILLIAM ISENBERG	323	2.388110
	11.78	053010550190	CHARLES J MILLER	325	2.387905
	11.79	053010550188	TERESA R MARCHI	326	2.387726
	11.81	053010550186	ANTHONY AND TERESA MARCHI	NA	2.387537
	11.84	053010550184	MICHAEL JOHN BERG	335	2.387355
	11.84	053010550185	JEFFREY A MILLER	313	2.387175

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Geophysical Score (highest to lowest)	11.86	053010550182	PATRICIA L MILLER	294	2.386985
	11.88	053010550142	JOHN ALDEN MALMANGER	251	2.386793
	11.89	053010550144	JEFFREY A MILLER	NA	2.386736
	12.65	053009140155	JOSEPH C BOWEN	NA	2.379846
	12.66	053009240000	ELISE GAGNON AND FRANKLIN J CATTON	NA	2.378249
	12.77	053009240050	JEFFERY L AND REBECCA CHEN	NA	2.377691
	12.80	053009240075	BURT W REID	NA	2.377125
	10.78	053002309070	WHITEGIVER-SCHMITZ	NA	2.376210
	12.88	053009231000	GEORGE C RAINS SR LIVING TRST	NA	2.376067
	10.84	053002309060	WHITEGIVER-SCHMITZ	NA	2.375330
	10.87	053002309050	WHITEGIVER-SCHMITZ	NA	2.374872
	10.91	053002309030	JOHN A SCHMITZ TTE	NA	2.374359
	10.94	053002309020	JOHN A SCHMITZ TTE	NA	2.373716
	10.98	053002309010	HANS AND BEVERLY BAILEY	NA	2.373171
	10.98	053002309110	RICHARD L ADAM	NA	2.372513
	11.02	053002309100	CARL T AND KATHIE M ZETTERBERG	NA	2.371908
	11.05	053002309090	RICHARD L ADAM	NA	2.371405
	11.10	053010560182	TARKY SUE PETERSEN AND ERIC C HEIM	323	2.370787
	11.14	053010560218	DENNIS/REGINA THOMASSEN	328	2.370191
	11.16	053010560220	CLAIRE J AND BONNIE C GILSTAD TTES	281	2.369810
	11.19	053010560148	JOHN A LAYDEN	301	2.369182
	11.22	053010560150	ALICE CLARK	263	2.368802
	11.22	053010560152	ALICE CLARK AND MICHAEL BELL	NA	2.368514
	13.23	053008510000	ALVIN F OIEN ET AL TC	NA	2.346457
	13.21	053008110100	JOHN R WEBB	NA	2.346314
	13.32	053008510426	GEORGE H SCHOENFELDT	210	2.346048
	13.34	053008510425	GEORGE H SCHOENFELDT	NA	2.346040
	13.36	053008510400	RONALD AND CAROL BROWNING	302	2.345894
	13.39	053005510060	FREDRICK MERRIN AND SYLVIA LYNN SCHWYHART	286	2.345774
	13.41	053005510055	DONALD AND ROZELLA TRACHY JTWROS	370	2.345657
	13.45	053005510075	LINDA ANN AND RICHARD THOMAS SMITH	286	2.345486
	13.48	053005510080	EARL AND PATRICIA BRUNNER	344	2.345354
	13.54	053005400050	JOHN AND NINA PURCELL TTES	146	2.345175
	13.52	053005510000	JANE S AND JAMES G PRYNE	349	2.345163
	13.54	053005510007	SANDRA BETTGER TTE	NA	2.345031
	13.57	053005500055	PHILLIP AND MARCIA LABOSSIERE	NA	2.344934
	13.60	053005500060	LANCE C AND CLAY J RICHMOND	275	2.344819
	10.50	053002300150	EVELYN M PLANT TTE	NA	0.580470



Appendix B

Parcel Geophysical Scores Sorted from East to West

Appendix B: Geophysical Scores arranged from east to west.

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Arranged by Drift Cell Mile (east to west)	5.95	043133339030	AIDA ACRA KATTAN	NA	10.000000
	5.97	043133339020	AIDA ACRA KATTAN	NA	9.040743
	5.99	043133339010	AIDA ACRA KATTAN	NA	8.680114
	6.01	043133339150	AIDA ACRA KATTAN	NA	8.390113
	6.02	043133339040	AIDA ACRA KATTAN	NA	6.126122
	6.03	043133339140	AIDA ACRA KATTAN	NA	8.137895
	6.05	043133339130	AIDA ACRA KATTAN	NA	7.937934
	6.05	043133339090	AIDA ACRA KATTAN	NA	5.524394
	6.06	043133339160	AIDA ACRA KATTAN	NA	5.924846
	6.07	043133339070	AIDA ACRA KATTAN	NA	7.770302
	6.09	043133339060	AIDA ACRA KATTAN	NA	7.620957
	6.09	043133339100	AIDA ACRA KATTAN	NA	5.387238
	6.12	043133339050	AIDA ACRA KATTAN	NA	7.489237
	6.12	043133339080	AIDA ACRA KATTAN	NA	5.703021
	6.15	043133359080	WALKER SURVIVORS TRUST	NA	5.434691
	6.17	043133359060	THOMAS R MC COOL TTE	69	7.363308
	6.17	043133359050	DANIEL R AND LINDA S MASYS	46	7.247098
	6.17	043133359070	REBECCA S CORLEY	233	5.346200
	6.19	043133359120	TROY AND STEPHANIE WARD	NA	7.151583
	6.21	043133359140	PRISCILLA K RAYMOND	74	7.154712
	6.22	043133359130	JAMES AND BEVERLY CONE TTES	173	5.193641
	6.24	043133359150	BOTHELL REV FAMILY TRUST	NA	5.098915
	6.26	043133359160	PAUL S THOMPSON TTE ET AL	NA	6.989232
	6.26	043133359170	BOTHELL REV FAMILY TRUST	53	5.096823
	6.31	043133339235	GEOFFREY WELLS TTE ET AL	64	6.863141
	6.35	043133330440	GARY AND KRYSTYNA GORDON TTES	84	6.763149
	6.40	043133330430	DR TIMOTHY B NEWLAND	96	6.681442
	6.43	043133339220	BENJAMIN C AND CATHERINE N KWAN TTES	NA	6.614915
	6.45	043133339210	FRANK AND SHARON BALESTRERY	NA	6.579266
	6.47	043133359040	BARRY H KANTOWITZ	65	6.571524
	6.48	043004229050	GEORGE S FRANCHINI	689	4.698646
	6.49	043133359030	CORBY SOMERVILLE AND J MARTIN	36	6.529110
	6.50	043004229100	WILLIAM AND SHARON CAMUSO TTES	496	4.684560
	6.51	043133359020	THOMAS AND MARILYN SCHLOSSER TC	NA	6.511298
	6.52	043004229090	JOSHUA ARMSTRONG	462	4.670509
	6.55	043004229140	STEVEN AND SHARON ROBINSON	NA	4.656116
	6.57	043004229130	DAVID AND MARJORIE WOODCOCK	NA	4.640861
	6.59	043133359010	JULIUS V SAKAS	21	6.494050
	6.59	043004229250	JOHN E DINIUS	152	4.627037
	6.60	043004229150	GARY AND SUSAN HENRICKSEN	556	4.605466
	6.61	043004229260	ELEANOR SCHOEN AND C ENGVALL TTES	59	6.431600
	6.62	043004229160	DAVID AND MARJORIE WOODCOCK	478	4.594195
	6.64	043004229240	JAMES AND KAREN FADDIS	NA	4.583113

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Arranged by Drift Cell Mile (east to west)	6.66	043005110100	AKE AND SIW ALMGREN	94	6.413124
	6.67	043005110200	SUZANNE M FLEMING	NA	6.383084
	6.67	043004229230	ROBERT AND ANNE MCGONIGEL JTROS	NA	4.572486
	6.67	043004229020	GLENDA MCLAREN	546	4.558907
	6.70	043004229010	JACK L HOLT	439	4.548359
	6.74	043004229040	RITA AND DAVID WISE	588	4.529333
	6.80	043005110175	JAMES C LOESCH	115	6.350388
	6.82	043005149040	LARRY AND GAIL ST PETER	631	4.496612
	6.85	043005140200	ROBERT J AND JOYCE M FILIP TRUSTEES	579	4.482613
	6.87	043005149020	ROBERT J AND JOYCE M FILIP TRUSTEES	NA	4.480896
	6.88	043005149030	LARRY AND JAN LITTLE AND M ROOSSIN	53	6.311478
	6.96	043005140300	RONALD AND NATALIE SALOIS JTWROS	NA	6.280407
	6.98	043005149000	JAMES AND THERESA STOVER	652	4.435763
	6.99	043005139010	JAMES R RIGGINS TRUST	49	6.252769
	7.02	043005140150	RAOUL AND MAUREEN SAID	NA	4.424084
	7.07	043005139020	IRIS I DUDLEY	232	4.411494
	7.08	043005139030	DOUGLAS B AND MERIKE NICHOLS	416	4.402574
	7.09	043005139040	MARK AND JACQUELYN WITTE	525	4.395265
	7.11	043005510370	MC DONNELL CRK RCH OWNERS ASSN	NA	6.219784
	7.22	043005130100	L D CHARF TRUST	NA	6.194963
	7.26	043005130050	MARJORY D BARTEE	192	6.209259
	7.27	043005310010	ALANNA AND JOHANNA AND NAOMI BARTEE	NA	6.180891
	7.27	043005420150	MARJORY D BARTEE	NA	4.365595
	7.30	043005420100	PAUL AND MARGARET PINZA	787	4.359617
	7.30	043005420160	MARJORY D BARTEE	288	4.357312
	7.31	043005429000	MARJORY D BARTEE	NA	4.351790
	7.32	043005310020	ALANNA AND JOHANNA AND NAOMI BARTEE	NA	6.170970
	7.33	043005429020	MARJORY D BARTEE	419	4.349836
	7.35	043005429010	MARJORY D BARTEE	502	4.346812
	7.40	043005310100	GEO BRALY AND KATHERINE M ROAT	88	6.155938
	7.44	043005310030	ALANNA AND JOHANNA AND NAOMI BARTEE	365	4.339534
	7.52	043005310040	ALANNA AND JOHANNA AND NAOMI BARTEE	NA	4.332097
	7.57	043005310125	THOMAS D AND JOAN F FITZPATRICK JT	NA	6.138527
	7.60	043005310140	THOMAS D AND JOAN F FITZPATRICK JT	324	4.317635
	7.61	043005329010	DAVID AND LISA MURPHY	81	6.131093
	7.64	043005320060	TERRANCE N AND CATHERINE J BENDOCK	114	6.126360
	7.65	043005329020	ROBERT AND LANI DRAKE	NA	4.305058
	7.67	043005329050	GLEN AND CAROL WILHELM TTES	102	6.122002
	7.68	043005329030	ARTHUR J BUHRER	NA	4.299966
	7.69	043005329110	ROGER C AND JUDY K WAGNER JOINT REV LIV TRUST	NA	6.117083
	7.73	043005320030	ROBERT G HATLESTAD	207	6.112833
	7.73	043005329040	THOMAS AND PENE SCHMOLKE	451	4.296973

	7.76	043005329100	ROGER C AND JUDY K WAGNER JOINT REV LIV TRUST	378	4.292899

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Arranged by Drift Cell Mile (east to west)	7.77	043005329070	RICHARD L AND SHIMAKO BUCK	124	6.108461
	7.81	043005339050	PETER REITER AND JONDA ROURKE TR	59	6.103992
	7.84	043005329060	RICHARD L AND SHIMAKO BUCK	NA	4.285735
	7.87	043005320225	SCOTT C WOLT	47	6.099951
	7.87	043005339060	PETER REITER AND JONDA ROURKE TR	NA	4.281301
	7.89	043006419110	WILLIAM I KOENIG	122	6.097926
	7.89	043005339070	SCOTT C WOLT	NA	4.279411
	7.91	043005339010	OSCAR G AND SUSAN A SANCHEZ TTE	NA	4.284814
	7.91	043005330040	MICHELE ERICKSON	670	4.277067
	7.92	043006419010	WILLIAM I KOENIG	NA	6.093569
	7.95	043006419100	WILLIAM I KOENIG	NA	4.273595
	7.96	043006410250	WILLIAM I KOENIG	103	6.090584
	7.97	043006419090	WILLIAM I KOENIG	NA	4.270881
	8.00	043006419020	WILLIAM I KOENIG	NA	4.268240
	8.01	043006419070	KATHRYN E ELLIS	222	6.087392
	8.03	043006419060	PHILLIP G AND BONNIE L KUCHLER	208	6.085607
	8.08	043006419030	DON J BRADLEY	97	6.083928
	8.09	043006510030	PETER AND DAWN WESTON WEBB	43	6.079969
	8.11	043006419040	DON J BRADLEY	NA	4.261590
	8.12	043006510020	DAVID M HOLLY	52	6.078121
	8.12	043006510040	PETER GRASSI AND SHIRLEY MCFADDEN	206	4.259734
	8.13	043006419050	DON J BRADLEY	NA	4.259684
	8.14	043006510010	CECIL L BLACK TTE	45	6.077019
	8.14	043006510050	GENEVA M KYDLAND TTE	274	4.258006
	8.14	043006510100	PAUL D AND CAROL A JENNINGS TTES	431	4.257076
	8.15	043006410100	BOB HAYS	49	6.075879
	8.15	043006510060	ELNA R CARROLL FAMILY TRUST	225	4.257056
	8.15	043006510090	NANCY L AVERY AND ELEANOR NAUMAN	388	4.256251
	8.15	043006510070	SHIRLEY RATE	250	4.256070
	8.16	043006510120	CHARLES A AND ETHEL BENTLEY TRUST	520	4.254401
	8.17	043006510080	KRISTINE AND ALAN JOHNSON	331	4.255396
	8.18	043006510130	KATHI L GUNN	514	4.253575
	8.19	043006510140	LINDA L FRAZER	490	4.252507
	8.20	043006500045	KATHLEEN E TRAINOR	272	4.252126
	8.21	043006500050	SHERRY LEE STOUT	199	6.070308
	8.22	043006500040	JOSEPH AND DORIS CAUGHEY ET AL	324	4.251880
	8.23	043006500057	MELVIN L HANSON	84	6.070155
	8.23	043006500035	JOHN R AND SUSAN L WILLETTE	374	4.250708
	8.24	043006500060	SCOTT S AND LINDA J PAULSON	39	6.069571
	8.24	043006500150	JACK AND NANCY METCALFE	218	4.249894
	8.25	043006500145	JUNE H MILES	296	4.249829
	8.25	043006500025	STEVEN AND CINDY RUNNION	469	4.248951
	8.25	043006500140	STEVEN AND ROBIN MASTERS	328	4.248851

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Arranged by Drift Cell Mile (east to west)	8.25	043006500015	ORUM D AND AGNES E MEDSKER	525	4.248047
	8.26	043006500065	EARL W MCDONALD	20	6.068702
	8.26	043006500070	ROGER AND VIRGINIA HUNTMAN	10	6.067548
	8.26	043006500155	DONALD L HECKATHORN TTE	147	4.249677
	8.26	043006500160	KENT BOSTER AND FRED AND KATHLEEN SWENSON JTWRS	145	4.248802
	8.26	043006500135	IAN D MACKENZIE	369	4.248054
	8.27	043006500075	JUDIE A RICH TTE	13	6.066628
	8.28	043006500165	JOHN D AND MAUREEN SEWELL	157	4.247799
	8.28	043006500010	WALTER J STAPISH	533	4.246213
	8.29	043006500080	J D ADAMS	34	6.065534
	8.29	043006500170	GERTRUD J WRIGHT-TRUST	239	4.247380
	8.29	043006500175	CARL AND SUSAN KAISER	294	4.246933
	8.30	043006500180	JENI AND DELON TURNER	363	4.246477
	8.30	043006500005	LAVINA BAUMANN	508	4.245583
	8.31	043006500090	DAVID AND PATRICIA VANDERGRIEND	87	6.064809
	8.32	043006500100	ALLEN/JULIE W TERRELL	144	4.246171
	8.32	043006500105	PAMELA J HANNA	213	4.245698
	8.32	043006500110	LAURNA KING AND RUTH LINGER JT	269	4.245240
	8.32	043006500115	ROBERT J AND JANICE M ORR	332	4.244832
	8.33	043007510140	PATRICK AND P A MORRISSEY	59	6.063487
	8.33	043006500120	WILIIAM A AND HELEN A WICK	382	4.244404
	8.33	043006500125	DAL H KILMER	446	4.244063
	8.34	043007510150	PEARLE L BRADLEY	229	4.244190
	8.34	043007510210	STEVEN B AND KATHY TUCKER	405	4.243287
	8.35	043007510130	ROY C AND JANIS FLANAGAN	62	6.062520
	8.36	043007510120	ARTHUR E SWARNICK	55	6.061487
	8.36	043007510160	JOHN AND MARY ANN HARTMAN	245	4.242898
	8.36	043007510200	ELAINE V ODER	356	4.242721
	8.36	043007510010	GENE L ROBINSON	545	4.241660
	8.37	043007510020	VERNON AND RUTH I MEADOWS	473	4.241206
	8.38	043007510110	ROBERT AND BARBARA HOUTZ	48	6.060585
	8.38	043007510190	STEVE AND CLARA LAKATOS	319	4.241710
	8.39	043007510170	FELICIAN AND R D VADON	215	4.241873
	8.39	043007510030	LAWRENCE P AND KLARA MORGAN	438	4.240396
	8.40	043007510180	BETTY LOU LONG	273	4.240659
	8.40	043007510040	MARJORIE SMOKE TTE	443	4.239634
	8.41	043007510100	DON AND PATRICIA MOFFETT	46	6.059594
	8.41	043007510050	R KEITH PARDUE	416	4.238849
	8.42	043007510090	THOMAS A AND TERESA M SCHMID	86	6.058275
	8.42	043007510060	JOHN AND EMILY LUENOW	354	4.238418
	8.43	043007510080	SANDRA P KELLO ET AL	203	4.239170
	8.43	043007500500	JOHN F AND JANET L CASSIO	509	4.237737
	8.44	043007510070	ROBERT AND KAREN AGEE	284	4.238541

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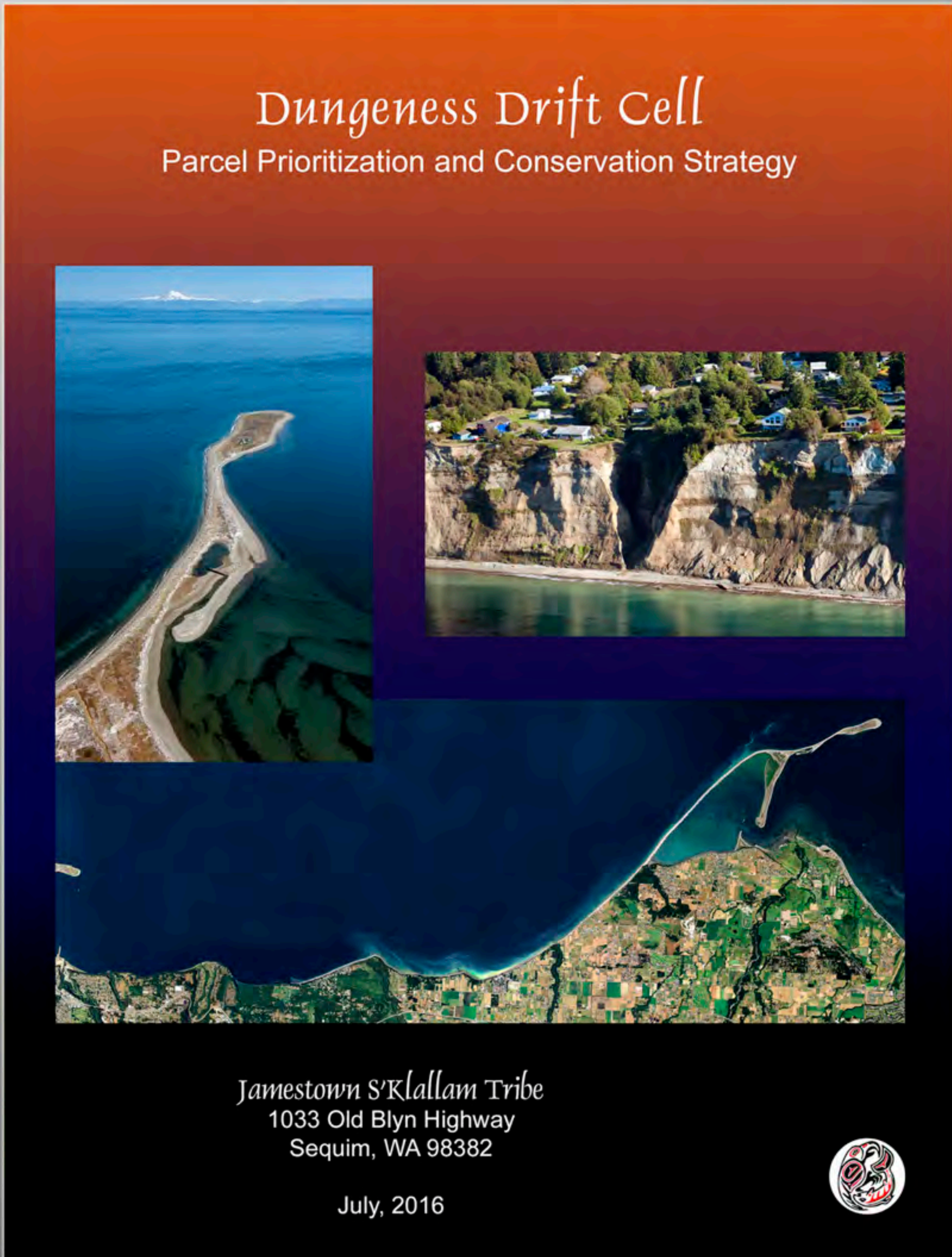
Arranged by Drift Cell Mile (east to west)	8.44	043007500600	DANIEL LIVRAMENTO	512	4.236427
	8.48	043007219080	MARION AND WANDA YANDELL	85	6.057885
	8.51	043007210050	BRIAN AND JANETH TOMLINSON	88	6.054522
	8.51	043007219110	JERRY E AND RONITA C FLACK	73	6.053000
	8.51	043007219090	BRENT L BERRY	512	4.235395
	8.54	043007219010	WILLIAM T BARTLETT,JR.	38	6.051179
	8.54	043007219070	ROBIN AND CAROL LEE MOSES	519	4.232079
	8.55	043007219120	DONALD AND JOANNE MORRISON	220	4.232753
	8.57	043007219060	JEFFREY P WHITE	437	4.230870
	8.60	043007219020	KENNETH AND CHIQUITA HIYOSHIDA	424	4.229305
	8.63	043007219220	JOHN AND JAMES FISKER ANDERSON	578	4.411567
	8.63	043007219240	ROBERT AND LINDA ADAMS TRUST	952	2.589665
	8.66	043007219210	RAYMON AND GEORGIANNA SEKO	383	4.410362
	8.67	043007220020	ALLEN AND RACHEL VANNESS	NA	4.409234
	8.74	043007220010	PETER SAARI	943	4.407659
	8.75	043007220060	KUEST FAMILY TRUST	484	4.406101
	8.78	043007220050	KUEST FAMILY TRUST	434	4.405336
	8.81	043007220125	KUEST FAMILY TRUST	71	4.404724
	8.92	043007228020	DAVID AND EVELYN BROWN	180	4.403996
	8.94	053012110000	GREEN SPRINGS ASPEN LLC	NA	4.402302
	8.97	053012110130	GREEN SPRINGS ASPEN LLC	NA	4.401704
	8.97	053012110135	DANIEL AND JANET ABBOTT	115	4.400873
	9.06	053012110145	DENNIS AND DIANE VENZON	72	4.398584
	9.12	053012110125	ROY G AND CHERIE L BROWN TTES	80	4.397517
	9.17	053012110100	EUGENE AND LINDA ANDERSON TTES	142	4.395241
	9.20	053012119010	STANTON AND CAROL CREASEY	185	4.393101
	9.23	053012120000	BARBARA C DRENNAN	289	4.392101
	9.27	053012128010	JESSE H BLAKE	344	4.389895
	9.33	053012129050	FLORENCE P HIGHTOWER TTE	116	4.387733
	9.39	053012129030	CARLTON W AND BERNIECE E CLEVELAND TTES	216	4.386565
	9.40	053012120125	SCOTT D AND GINGER L WIERZBANOWSKI	157	4.385284
	9.45	053012500100	MARJORY GRAUE	NA	4.383824
	9.48	053012500125	MARJORY GRAUE	NA	4.382785
	9.51	053012509450	PAUL D COOVER	134	4.381849
	9.64	053012500200	PACIFIC STAR INVESTMENTS LLC	182	4.379971
	9.67	053012500250	DW COLLIER CHARITABLE TRUST I AND W COLLIER FAM LLC	NA	4.378229
	9.67	053012500275	DOMAINE MADELEINE LLC	107	4.377649
	9.71	053012509250	CAPPY AND BETH ROTHMAN TTES	98	4.376809
	9.72	053012509470	ANN WEINER	NA	2.557089
	9.75	053012509240	CAPPY AND BETH ROTHMAN TTES	88	4.376654
	9.78	053012509480	ANN WEINER	46	4.376007
	9.80	053012500300	MARY ANN HUDSON	6	4.374995
	9.90	053012500400	HEARST AND JERRI COEN REV LIVING TRUST	84	4.373916

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Arranged by Drift Cell Mile (east to west)	9.97	053001300400	OTTO JR AND BILLIE STOEPLER	50	4.372440
	10.00	053002400050	MICHAEL J SCOTT	3	4.370927
	10.00	053011119000	HENRY AND SANDRA LEIS FAMILY REVOCABLE LIVING TRUST	NA	2.552284
	10.01	053002409010	PAUL ONOPIUK	49	4.370012
	10.01	053011500000	BRIAN SCOTT AND HEATHER JANE STAMON	219	2.551578
	10.03	053011500100	ROBERT G ELLIS	253	2.550935
	10.05	053011500200	DAVID B CANTON AND NANCY L MAYER	432	2.550292
	10.06	053002409020	SMITH FAMILY TRUST	51	4.369479
	10.07	053002400200	WALTER CAMERON AND SANDRA WALKER	79	4.368632
	10.07	053011500300	GARY R SWENSON	362	2.549651
	10.09	053011500400	RICHARD T AND DOROTHY A GRACE	580	2.549013
	10.10	053002400300	AMY J GREENLIEF	67	4.368224
	10.11	053002400150	GERHARD L AND MARY M HELLER	96	4.367875
	10.13	053002400400	GARY AND JUDY GOODWIN	NA	4.367505
	10.15	053002439000	R G AND MARGERY CROOK FAM TRUST	185	4.367188
	10.20	053002449000	TREADWELL FAMILY TRUST	237	4.366783
	10.23	053002400000	MORY AND BARBARA HOUSHMAND	333	4.366455
	10.30	053002439010	BRIAN AND JANETH TOMLINSON	79	4.365335
	10.32	053002400360	EVELYN M PLANT TTE	NA	2.401171
	10.44	053002400350	EVELYN M PLANT TTE	NA	2.400664
	10.50	053002300150	EVELYN M PLANT TTE	NA	0.580470
	10.65	053002300000	EVELYN M PLANT TTE	125	2.398721
	10.70	053002300050	EVELYN M PLANT TTE	NA	2.396014
	10.78	053002309070	WHITEGIVER-SCHMITZ	NA	2.376210
	10.84	053002309060	WHITEGIVER-SCHMITZ	NA	2.375330
	10.87	053002309045	WHITEGIVER-SCHMITZ	NA	4.194535
	10.87	053002309050	WHITEGIVER-SCHMITZ	NA	2.374872
	10.91	053002309030	JOHN A SCHMITZ TTE	NA	2.374359
	10.94	053002309020	JOHN A SCHMITZ TTE	NA	2.373716
	10.95	053002309005	JOHN A SCHMITZ TTE	NA	4.192691
	10.98	053002309085	RICHARD L ADAM	NA	4.190773
	10.98	053002309010	HANS AND BEVERLY BAILEY	NA	2.373171
	10.98	053002309110	RICHARD L ADAM	NA	2.372513
	11.02	053002309100	CARL T AND KATHIE M ZETTERBERG	NA	2.371908
	11.05	053002309090	RICHARD L ADAM	NA	2.371405
	11.06	053010560180	M DAVIS ESTATE	15	4.189244
	11.09	053010560178	NATALIE SPIEGEL	30	4.189103
	11.10	053010560176	JAMES AND PAMELA HARDIE	11	4.188826
	11.10	053010560182	TARKY SUE PETERSEN AND ERIC C HEIM	323	2.370787
	11.12	053010560174	JOHN AND VICKI L PASALICH	50	4.188471
	11.14	053010560172	DAVID AND CECILIA COLBY	69	4.188228
	11.14	053010560218	DENNIS/REGINA THOMASSEN	328	2.370191
	11.15	053010560170	GARY E SJOROOS	45	4.187997

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Arranged by Drift Cell Mile (east to west)	11.16	053010560168	CLAIRE J AND BONNIE C GILSTAD TTES	32	4.187749
	11.16	053010560220	CLAIRE J AND BONNIE C GILSTAD TTES	281	2.369810
	11.17	053010560166	RICHARD A AND PAULINE J CALLIS	49	4.187523
	11.19	053010560164	RAYMOND N AND C BRAUN	26	4.187304
	11.19	053010560148	JOHN A LAYDEN	301	2.369182
	11.20	053010560162	STEPHEN D MULDER AND BETH E MULDER CO-TTE	34	4.187059
	11.22	053010560159	FEDERAL HOME LOAN MORT CORP	6	4.186835
	11.22	053010560150	ALICE CLARK	263	2.368802
	11.22	053010560152	ALICE CLARK AND MICHAEL BELL	NA	2.368514
	11.25	053010560155	RICHARD C AND MILDRED D JOHNSEN JOINT LIVING TRUST	84	4.186435
	11.25	053010560140	RICHARD V AND PAMELA J EHTEE LIVING TRUST	422	2.395664
	11.25	053010560138	JEFFREY A LITTELL	253	2.395353
	11.28	053010560136	DEREK REED TTE	144	4.213250
	11.29	053010560134	KEITH AND SANDRA L PATTISON TTES	66	4.212981
	11.33	053010560130	WILLIAM E AND JULIA ANN N GOTTHOLD TTES	14	4.212754
	11.33	053010560128	KELLY PATRICK BURKE	15	4.212301
	11.33	053010560244	TYLER J AND OLIVIA P AVERY	323	2.394453
	11.34	053010560126	STEVEN P BRIDGE	27	4.212099
	11.36	053010110000	FRED WAGNER	NA	2.397157
	11.36	053010560246	ERICKSON LOGGING II LLC	NA	2.394188
	11.37	053010560124	ROBERT AND ROBIN BORDONARO	66	4.211892
	11.38	053010560122	ROBERT E AND E M BROWN	62	4.211672
	11.39	053010560249	JOHN M AND CHARMAYNE D HURLBUT	357	2.393677
	11.40	053010560120	TONY I AND CONNIE J LITTLE	10	4.211473
	11.41	053010560118	TONY I AND CONNIE J LITTLE	NA	4.211286
	11.42	053010560348	TONY I AND CONNIE J LITTLE	NA	2.393082
	11.43	053010560346	THOMAS J LAROSA	314	2.392815
	11.44	053010560115	MONTY AND SHERRY WEBB	67	4.211074
	11.45	053010560112	MONTY AND SHERRY WEBB	NA	4.210641
	11.46	053010560342	IRENE R SCHAFFNER	318	2.392605
	11.47	053010560110	JERRY A SCHNATTERLY	60	4.210437
	11.48	053010560108	JERRY A SCHNATTERLY	37	4.210225
	11.48	053010560340	LUIGI L NICOLOSO	313	2.392182
	11.49	053010560106	KAREN STEINMAUS	NA	4.210019
	11.49	053010560338	GLEN KOBATA	NA	2.391972
	11.50	053010560336	DONALD KRAUS	338	2.391769
	11.51	053010560104	KAREN STEINMAUS	83	4.209823
	11.52	053010560102	MILTON AND FAYRENE KENOYER	NA	4.209617
	11.54	053010560100	EUGENE AND JEANNE BLAETTLER	73	4.209421
	11.54	053010560334	LARRY D DOUGLAS	356	2.391395
	11.55	053010550140	ROBERT S BROWN	NA	4.209212
	11.55	053010550312	GLEN KOBATA	NA	2.391076
	11.56	053010550138	JACK LEON LA FORGE	109	4.209002

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Arranged by Drift Cell Mile (east to west)	11.56	053010550314	JOHN AND SANDRA STEPHENS	666	2.391301
	11.57	053010550135	DONALD HILYARD AND G S LALONDE	90	4.208809
	11.59	053010550254	KIMI HOYLE	NA	2.390585
	11.59	053010550252	MICHAEL AND ANN BUELL REVOCABLE TRUST	398	2.390314
	11.61	053010550250	CHARLES E LEACH AND B A POZNANOVIC	NA	2.390100
	11.62	053010550248	CHARLES E LEACH AND B A POZNANOVIC	316	2.389899
	11.64	053010550244	DONALD AND COLLEEN DALEY	320	2.389688
	11.65	053010550130	DONALD HILYARD AND G S LALONDE	NA	4.208055
	11.65	053010550128	ANDREW M AND JEANETTA J JOHNSON	101	4.207708
	11.68	053010550242	THOMAS AND SHARON FRITSCHLER	NA	2.389192
	11.69	053010550126	ROSS L CANNING	68	4.207146
	11.69	053010550240	THOMAS AND SHARON FRITSCHLER	378	2.388928
	11.70	053010550122	JOSEPH AND PAULINE PRETI TTES	81	4.206965
	11.71	053010550238	EUGENE J AND JO CAVANAGH	372	2.388737
	11.72	053010550194	BARBARA K HORACEK TTE	309	2.388534
	11.73	053010550120	GUENTHER HERZ TTE	68	4.206623
	11.76	053010570020	PHILIP K URATA	45	4.206442
	11.77	053010550192	WILLIAM ISENBERG	323	2.388110
	11.78	053010550190	CHARLES J MILLER	325	2.387905
	11.79	053010570010	CHRISTOPHER D SAARI	19	4.206167
	11.79	053010550188	TERESA R MARCHI	326	2.387726
	11.81	053010550110	CRAIG SMITH AND MARY HEFFERMAN	132	4.205883
	11.81	053010550186	ANTHONY AND TERESA MARCHI	NA	2.387537
	11.83	053010550108	LARRY D DOUGLAS	106	4.205517
	11.84	053010550106	FERYDUN AND LAGHAIEH REZVANI TTE	NA	4.205336
	11.84	053010550104	PETER A LAVELLE	87	4.205149
	11.84	053010550184	MICHAEL JOHN BERG	335	2.387355
	11.84	053010550185	JEFFREY A MILLER	313	2.387175
	11.86	053010550182	PATRICIA L MILLER	294	2.386985
	11.87	053010550102	SUE ELAINE RAINEY	33	4.204989
	11.88	053010550100	EDWIN C MURPHY	15	4.204799
	11.88	053010550142	JOHN ALDEN MALMANGER	251	2.386793
	11.89	053010550144	JEFFREY A MILLER	NA	2.386736
	11.91	053010230140	DON AND CHARLENE HENSLEE	NA	4.204609
	11.94	053010230130	DON AND CHARLENE HENSLEE	NA	4.204221
	11.98	053010230120	JOHN WARRICK AND RUTH JENKINS TTES	NA	4.203845
	12.00	053010230110	JOHN WARRICK AND RUTH JENKINS TTES	68	4.203471
	12.03	053010230105	JOHN WARRICK AND RUTH JENKINS TTES	NA	4.203118
	12.04	053010230090	MICHAEL T AND D M OLSON	246	4.202780
	12.09	053010230080	MICHAEL AND DINA OLSON	NA	4.202441
	12.12	053009140070	JOHN WARRICK AND RUTH JENKINS TTES	153	4.202101
	12.21	053009140030	GEORGE E AND CATHERINE M LANHAM	91	4.200826
	12.24	053009140020	JUDY L PALLAGI	54	4.200538

Arranged by Drift Cell Mile (east to west)	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
	12.27	053009140010	SYLVIA FEDER	NA	4.200249
	12.35	053009140120	JEANINE CARDIFF	209	4.199954
	12.38	053009140100	JOHN WARRICK AND RUTH JENKINS TTES	NA	4.199300
	12.52	053009120252	NANCY J MCLAUGHLIN TTE	333	4.198720
	12.57	053009120270	DAVID M THOMPSON	NA	4.197748
	12.59	053009120350	JESSIE A AND SANDY L HYCHE	NA	4.197098
	12.65	053009210000	BURT W REID	NA	4.196536
	12.65	053009140155	JOSEPH C BOWEN	NA	2.379846
	12.66	053009240000	ELISE GAGNON AND FRANKLIN J CATTON	NA	2.378249
	12.77	053009240050	JEFFERY L AND REBECCA CHEN	NA	2.377691
	12.80	053009240075	BURT W REID	NA	2.377125
	12.88	053009231000	GEORGE C RAINS SR LIVING TRST	NA	2.376067
	13.14	053009221000	GEORGE C RAINS SR LIVING TRST	NA	4.194312
	13.17	053008110000	GEORGE C RAINS SR LIVING TRST	NA	4.192373
	13.18	053008510100	GEORGE C RAINS SR LIVING TRST	39	4.164928
	13.21	053008110100	JOHN R WEBB	NA	2.346314
	13.23	053008510000	ALVIN F OIEN ET AL TC	NA	2.346457
	13.26	053008510020	DAVID K AND MARIA S TEBOW	114	4.164653
	13.32	053008510426	GEORGE H SCHOENFELDT	210	2.346048
	13.34	053008510425	GEORGE H SCHOENFELDT	NA	2.346040
	13.36	053008510400	RONALD AND CAROL BROWNING	302	2.345894
	13.39	053008510030	RICHARD J SCHOENFELDT	1	4.164342
	13.39	053005510060	FREDRICK MERRIN AND SYLVIA LYNN SCHWYHART	286	2.345774
	13.41	053005510055	DONALD AND ROZELLA TRACHY JTWROS	370	2.345657
	13.42	053005510065	HALL SURVIVORS TRUST	NA	4.164086
	13.45	053005510070	ROBERTA J FISHER TTE	184	4.163848
	13.45	053005510075	LINDA ANN AND RICHARD THOMAS SMITH	286	2.345486
	13.48	053005510085	DAVID J SALVETER	192	4.163725
	13.48	053005510080	EARL AND PATRICIA BRUNNER	344	2.345354
	13.52	053005510000	JANE S AND JAMES G PRYNE	349	2.345163
	13.54	053005400000	JOHN AND NINA PURCELL TTES	NA	4.163729
	13.54	053005400050	JOHN AND NINA PURCELL TTES	146	2.345175
	13.54	053005510007	SANDRA BETTGER TTE	NA	2.345031
	13.57	053005500050	CECIL C WHITE	26	4.163363
	13.57	053005500055	PHILLIP AND MARCIA LABOSSIERE	NA	2.344934
	13.59	053005500045	STEVE AND MIRJA WILSON	7	4.163190
	13.60	053005500060	LANCE C AND CLAY J RICHMOND	275	2.344819
	13.61	053005500040	JOSEPH T WANNER	1	4.163083



Appendix C

Geophysical Scores Sorted by Parcel Number

Appendix C: Geophysical Scores sorted by parcel number.

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Parcel Number (smallest to largest)	6.70	043004229010	JACK L HOLT	439	4.548359
	6.67	043004229020	GLENDA MCLAREN	546	4.558907
	6.74	043004229040	RITA AND DAVID WISE	588	4.529333
	6.48	043004229050	GEORGE S FRANCHINI	689	4.698646
	6.52	043004229090	JOSHUA ARMSTRONG	462	4.670509
	6.50	043004229100	WILLIAM AND SHARON CAMUSO TTES	496	4.684560
	6.57	043004229130	DAVID AND MARJORIE WOODCOCK	NA	4.640861
	6.55	043004229140	STEVEN AND SHARON ROBINSON	NA	4.656116
	6.60	043004229150	GARY AND SUSAN HENRICKSEN	556	4.605466
	6.62	043004229160	DAVID AND MARJORIE WOODCOCK	478	4.594195
	6.67	043004229230	ROBERT AND ANNE MCGONIGEL JTROS	NA	4.572486
	6.64	043004229240	JAMES AND KAREN FADDIS	NA	4.583113
	6.59	043004229250	JOHN E DINIUS	152	4.627037
	6.61	043004229260	ELEANOR SCHOEN AND C ENGVALL TTES	59	6.431600
	6.66	043005110100	AKE AND SIW ALMGREN	94	6.413124
	6.80	043005110175	JAMES C LOESCH	115	6.350388
	6.67	043005110200	SUZANNE M FLEMING	NA	6.383084
	7.26	043005130050	MARJORY D BARTEE	192	6.209259
	7.22	043005130100	L D CHARF TRUST	NA	6.194963
	6.99	043005139010	JAMES R RIGGINS TRUST	49	6.252769
	7.07	043005139020	IRIS I DUDLEY	232	4.411494
	7.08	043005139030	DOUGLAS B AND MERIKE NICHOLS	416	4.402574
	7.09	043005139040	MARK AND JACQUELYN WITTE	525	4.395265
	7.02	043005140150	RAOUL AND MAUREEN SAID	NA	4.424084
	6.85	043005140200	ROBERT J AND JOYCE M FILIP TRUSTEES	579	4.482613
	6.96	043005140300	RONALD AND NATALIE SALOIS JTWROS	NA	6.280407
	6.98	043005149000	JAMES AND THERESA STOVER	652	4.435763
	6.87	043005149020	ROBERT J AND JOYCE M FILIP TRUSTEES	NA	4.480896
	6.88	043005149030	LARRY AND JAN LITTLE AND M ROOSSIN	53	6.311478
	6.82	043005149040	LARRY AND GAIL ST PETER	631	4.496612
	7.27	043005310010	ALANNA AND JOHANNA AND NAOMI BARTEE	NA	6.180891
	7.32	043005310020	ALANNA AND JOHANNA AND NAOMI BARTEE	NA	6.170970
	7.44	043005310030	ALANNA AND JOHANNA AND NAOMI BARTEE	365	4.339534
	7.52	043005310040	ALANNA AND JOHANNA AND NAOMI BARTEE	NA	4.332097
	7.40	043005310100	GEO BRALY AND KATHERINE M ROAT	88	6.155938
	7.57	043005310125	THOMAS D AND JOAN F FITZPATRICK JT	NA	6.138527
	7.60	043005310140	THOMAS D AND JOAN F FITZPATRICK JT	324	4.317635
	7.73	043005320030	ROBERT G HATLESTAD	207	6.112833
	7.64	043005320060	TERRANCE N AND CATHERINE J BENDOCK	114	6.126360
	7.87	043005320225	SCOTT C WOLT	47	6.099951
	7.61	043005329010	DAVID AND LISA MURPHY	81	6.131093
	7.65	043005329020	ROBERT AND LANI DRAKE	NA	4.305058
	7.68	043005329030	ARTHUR J BUHRER	NA	4.299966

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Parcel Number (smallest to largest)	7.73	043005329040	THOMAS AND PENE SCHMOLKE	451	4.296973
	7.67	043005329050	GLEN AND CAROL WILHELM TTES	102	6.122002
	7.84	043005329060	RICHARD L AND SHIMAKO BUCK	NA	4.285735
	7.77	043005329070	RICHARD L AND SHIMAKO BUCK	124	6.108461
	7.76	043005329100	ROGER C AND JUDY K WAGNER JOINT REV LIV TRUST	378	4.292899
	7.69	043005329110	ROGER C AND JUDY K WAGNER JOINT REV LIV TRUST	NA	6.117083
	7.91	043005330040	MICHELE ERICKSON	670	4.277067
	7.91	043005339010	OSCAR G AND SUSAN A SANCHEZ TTE	NA	4.284814
	7.81	043005339050	PETER REITER AND JONDA ROURKE TR	59	6.103992
	7.87	043005339060	PETER REITER AND JONDA ROURKE TR	NA	4.281301
	7.89	043005339070	SCOTT C WOLT	NA	4.279411
	7.30	043005420100	PAUL AND MARGARET PINZA	787	4.359617
	7.27	043005420150	MARJORY D BARTEE	NA	4.365595
	7.30	043005420160	MARJORY D BARTEE	288	4.357312
	7.31	043005429000	MARJORY D BARTEE	NA	4.351790
	7.35	043005429010	MARJORY D BARTEE	502	4.346812
	7.33	043005429020	MARJORY D BARTEE	419	4.349836
	7.11	043005510370	MC DONNELL CRK RCH OWNERS ASSN	NA	6.219784
	8.15	043006410100	BOB HAYS	49	6.075879
	7.96	043006410250	WILLIAM I KOENIG	103	6.090584
	7.92	043006419010	WILLIAM I KOENIG	NA	6.093569
	8.00	043006419020	WILLIAM I KOENIG	NA	4.268240
	8.08	043006419030	DON J BRADLEY	97	6.083928
	8.11	043006419040	DON J BRADLEY	NA	4.261590
	8.13	043006419050	DON J BRADLEY	NA	4.259684
	8.03	043006419060	PHILLIP G AND BONNIE L KUCHLER	208	6.085607
	8.01	043006419070	KATHRYN E ELLIS	222	6.087392
	7.97	043006419090	WILLIAM I KOENIG	NA	4.270881
	7.95	043006419100	WILLIAM I KOENIG	NA	4.273595
	7.89	043006419110	WILLIAM I KOENIG	122	6.097926
	8.30	043006500005	LAVINA BAUMANN	508	4.245583
	8.28	043006500010	WALTER J STAPISH	533	4.246213
	8.25	043006500015	ORUM D AND AGNES E MEDSKER	525	4.248047
	8.25	043006500025	STEVEN AND CINDY RUNNION	469	4.248951
	8.23	043006500035	JOHN R AND SUSAN L WILLETTE	374	4.250708
	8.22	043006500040	JOSEPH AND DORIS CAUGHEY ET AL	324	4.251880
	8.20	043006500045	KATHLEEN E TRAINOR	272	4.252126
	8.21	043006500050	SHERRY LEE STOUT	199	6.070308
	8.23	043006500057	MELVIN L HANSON	84	6.070155
	8.24	043006500060	SCOTT S AND LINDA J PAULSON	39	6.069571
	8.26	043006500065	EARL W MCDONALD	20	6.068702
	8.26	043006500070	ROGER AND VIRGINIA HUNTMAN	10	6.067548
	8.27	043006500075	JUDIE A RICH TTE	13	6.066628

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Parcel Number (smallest to largest)	8.29	043006500080	J D ADAMS	34	6.065534
	8.31	043006500090	DAVID AND PATRICIA VANDERGRIEND	87	6.064809
	8.32	043006500100	ALLEN/JULIE W TERRELL	144	4.246171
	8.32	043006500105	PAMELA J HANNA	213	4.245698
	8.32	043006500110	LAURNA KING AND RUTH LINGER JT	269	4.245240
	8.32	043006500115	ROBERT J AND JANICE M ORR	332	4.244832
	8.33	043006500120	WILIIAM A AND HELEN A WICK	382	4.244404
	8.33	043006500125	DAL H KILMER	446	4.244063
	8.26	043006500135	IAN D MACKENZIE	369	4.248054
	8.25	043006500140	STEVEN AND ROBIN MASTERS	328	4.248851
	8.25	043006500145	JUNE H MILES	296	4.249829
	8.24	043006500150	JACK AND NANCY METCALFE	218	4.249894
	8.26	043006500155	DONALD L HECKATHORN TTE	147	4.249677
	8.26	043006500160	KENT BOSTER AND FRED AND KATHLEEN SWENSON JTWRS	145	4.248802
	8.28	043006500165	JOHN D AND MAUREEN SEWELL	157	4.247799
	8.29	043006500170	GERTRUD J WRIGHT-TRUST	239	4.247380
	8.29	043006500175	CARL AND SUSAN KAISER	294	4.246933
	8.30	043006500180	JENI AND DELON TURNER	363	4.246477
	8.14	043006510010	CECIL L BLACK TTE	45	6.077019
	8.12	043006510020	DAVID M HOLLY	52	6.078121
	8.09	043006510030	PETER AND DAWN WESTON WEBB	43	6.079969
	8.12	043006510040	PETER GRASSI AND SHIRLEY MCFADDEN	206	4.259734
	8.14	043006510050	GENEVA M KYDLAND TTE	274	4.258006
	8.15	043006510060	ELNA R CARROLL FAMILY TRUST	225	4.257056
	8.15	043006510070	SHIRLEY RATE	250	4.256070
	8.17	043006510080	KRISTINE AND ALAN JOHNSON	331	4.255396
	8.15	043006510090	NANCY L AVERY AND ELEANOR NAUMAN	388	4.256251
	8.14	043006510100	PAUL D AND CAROL A JENNINGS TTES	431	4.257076
	8.16	043006510120	CHARLES A AND ETHEL BENTLEY TRUST	520	4.254401
	8.18	043006510130	KATHI L GUNN	514	4.253575
	8.19	043006510140	LINDA L FRAZER	490	4.252507
	8.51	043007210050	BRIAN AND JANETH TOMLINSON	88	6.054522
	8.54	043007219010	WILLIAM T BARTLETT,JR.	38	6.051179
	8.60	043007219020	KENNETH AND CHIQUITA HIYOSHIDA	424	4.229305
	8.57	043007219060	JEFFREY P WHITE	437	4.230870
	8.54	043007219070	ROBIN AND CAROL LEE MOSES	519	4.232079
	8.48	043007219080	MARION AND WANDA YANDELL	85	6.057885
	8.51	043007219090	BRENT L BERRY	512	4.235395
	8.51	043007219110	JERRY E AND RONITA C FLACK	73	6.053000
	8.55	043007219120	DONALD AND JOANNE MORRISON	220	4.232753
	8.66	043007219210	RAYMON AND GEORGIANNA SEKO	383	4.410362
	8.63	043007219220	JOHN AND JAMES FISKER ANDERSON	578	4.411567
	8.63	043007219240	ROBERT AND LINDA ADAMS TRUST	952	2.589665

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Parcel Number (smallest to largest)	8.74	043007220010	PETER SAARI	943	4.407659
	8.67	043007220020	ALLEN AND RACHEL VANNESS	NA	4.409234
	8.78	043007220050	KUEST FAMILY TRUST	434	4.405336
	8.75	043007220060	KUEST FAMILY TRUST	484	4.406101
	8.81	043007220125	KUEST FAMILY TRUST	71	4.404724
	8.92	043007228020	DAVID AND EVELYN BROWN	180	4.403996
	8.43	043007500500	JOHN F AND JANET L CASSIO	509	4.237737
	8.44	043007500600	DANIEL LIVRAMENTO	512	4.236427
	8.36	043007510010	GENE L ROBINSON	545	4.241660
	8.37	043007510020	VERNON AND RUTH I MEADOWS	473	4.241206
	8.39	043007510030	LAWRENCE P AND KLARA MORGAN	438	4.240396
	8.40	043007510040	MARJORIE SMOKE TTE	443	4.239634
	8.41	043007510050	R KEITH PARDUE	416	4.238849
	8.42	043007510060	JOHN AND EMILY LUENOW	354	4.238418
	8.44	043007510070	ROBERT AND KAREN AGEE	284	4.238541
	8.43	043007510080	SANDRA P KELLO ET AL	203	4.239170
	8.42	043007510090	THOMAS A AND TERESA M SCHMID	86	6.058275
	8.41	043007510100	DON AND PATRICIA MOFFETT	46	6.059594
	8.38	043007510110	ROBERT AND BARBARA HOUTZ	48	6.060585
	8.36	043007510120	ARTHUR E SWARNICK	55	6.061487
	8.35	043007510130	ROY C AND JANIS FLANAGAN	62	6.062520
	8.33	043007510140	PATRICK AND P A MORRISSEY	59	6.063487
	8.34	043007510150	PEARLE L BRADLEY	229	4.244190
	8.36	043007510160	JOHN AND MARY ANN HARTMAN	245	4.242898
	8.39	043007510170	FELICIAN AND R D VADON	215	4.241873
	8.40	043007510180	BETTY LOU LONG	273	4.240659
	8.38	043007510190	STEVE AND CLARA LAKATOS	319	4.241710
	8.36	043007510200	ELAINE V ODER	356	4.242721
	8.34	043007510210	STEVEN B AND KATHY TUCKER	405	4.243287
	6.40	043133330430	DR TIMOTHY B NEWLAND	96	6.681442
	6.35	043133330440	GARY AND KRYSTYNA GORDON TTES	84	6.763149
	5.99	043133339010	AIDA ACRA KATTAN	NA	8.680114
	5.97	043133339020	AIDA ACRA KATTAN	NA	9.040743
	5.95	043133339030	AIDA ACRA KATTAN	NA	10.000000
	6.02	043133339040	AIDA ACRA KATTAN	NA	6.126122
	6.12	043133339050	AIDA ACRA KATTAN	NA	7.489237
	6.09	043133339060	AIDA ACRA KATTAN	NA	7.620957
	6.07	043133339070	AIDA ACRA KATTAN	NA	7.770302
	6.12	043133339080	AIDA ACRA KATTAN	NA	5.703021
	6.05	043133339090	AIDA ACRA KATTAN	NA	5.524394
	6.09	043133339100	AIDA ACRA KATTAN	NA	5.387238
	6.05	043133339130	AIDA ACRA KATTAN	NA	7.937934
	6.03	043133339140	AIDA ACRA KATTAN	NA	8.137895

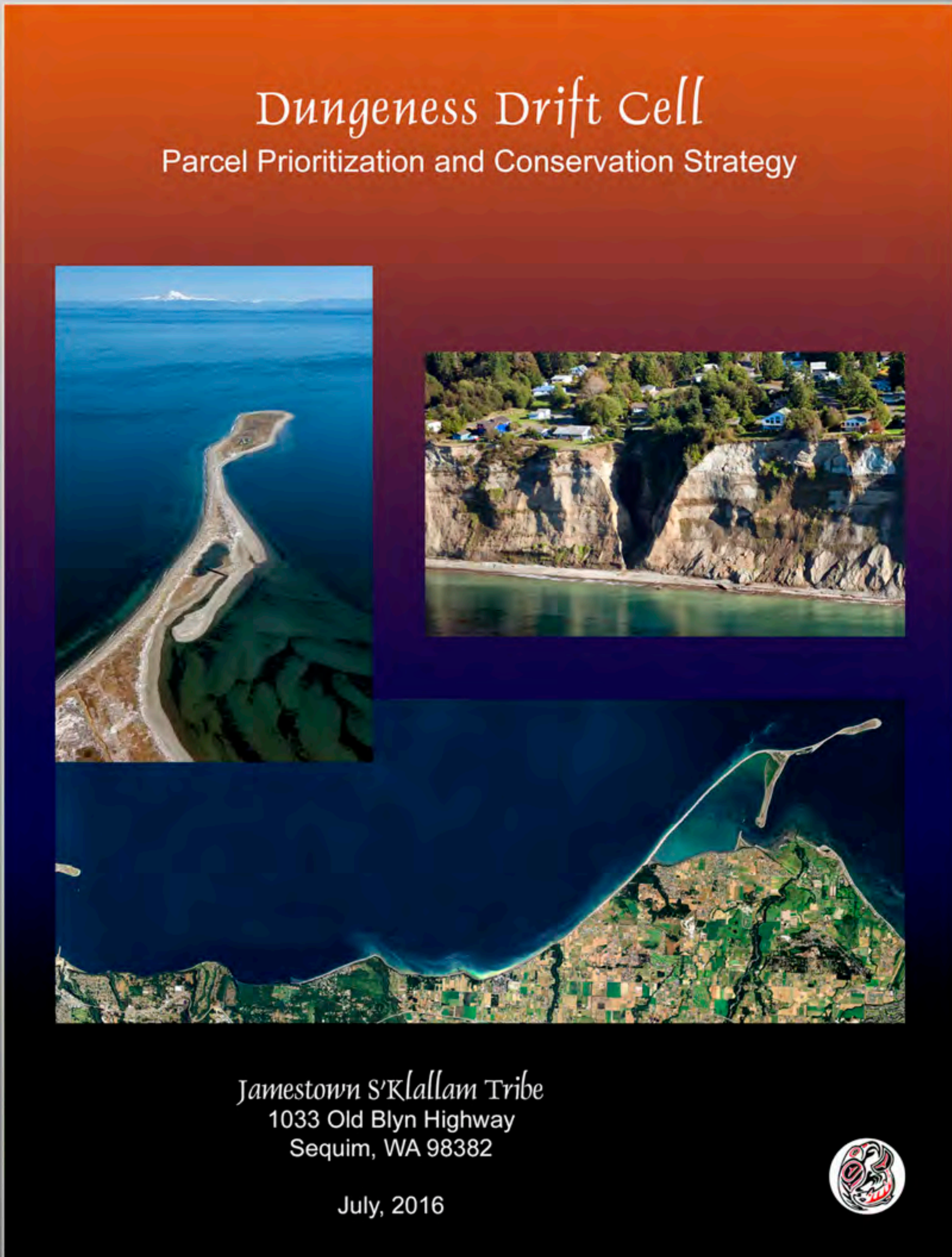
	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Parcel Number (smallest to largest)	6.01	043133339150	AIDA ACRA KATTAN	NA	8.390113
	6.06	043133339160	AIDA ACRA KATTAN	NA	5.924846
	6.45	043133339210	FRANK AND SHARON BALESTRERY	NA	6.579266
	6.43	043133339220	BENJAMIN C AND CATHERINE N KWAN TTES	NA	6.614915
	6.31	043133339235	GEOFFREY WELLS TTE ET AL	64	6.863141
	6.59	043133359010	JULIUS V SAKAS	21	6.494050
	6.51	043133359020	THOMAS AND MARILYN SCHLOSSER TC	NA	6.511298
	6.49	043133359030	CORBY SOMERVILLE AND J MARTIN	36	6.529110
	6.47	043133359040	BARRY H KANTOWITZ	65	6.571524
	6.17	043133359050	DANIEL R AND LINDA S MASYS	46	7.247098
	6.17	043133359060	THOMAS R MC COOL TTE	69	7.363308
	6.17	043133359070	REBECCA S CORLEY	233	5.346200
	6.15	043133359080	WALKER SURVIVORS TRUST	NA	5.434691
	6.19	043133359120	TROY AND STEPHANIE WARD	NA	7.151583
	6.22	043133359130	JAMES AND BEVERLY CONE TTES	173	5.193641
	6.21	043133359140	PRISCILLA K RAYMOND	74	7.154712
	6.24	043133359150	BOTHELL REV FAMILY TRUST	NA	5.098915
	6.26	043133359160	PAUL S THOMPSON TTE ET AL	NA	6.989232
	6.26	043133359170	BOTHELL REV FAMILY TRUST	53	5.096823
	9.97	053001300400	OTTO JR AND BILLIE STOEPLER	50	4.372440
	10.65	053002300000	EVELYN M PLANT TTE	125	2.398721
	10.70	053002300050	EVELYN M PLANT TTE	NA	2.396014
	10.50	053002300150	EVELYN M PLANT TTE	NA	0.580470
	10.95	053002309005	JOHN A SCHMITZ TTE	NA	4.192691
	10.98	053002309010	HANS AND BEVERLY BAILEY	NA	2.373171
	10.94	053002309020	JOHN A SCHMITZ TTE	NA	2.373716
	10.91	053002309030	JOHN A SCHMITZ TTE	NA	2.374359
	10.87	053002309045	WHITEGIVER-SCHMITZ	NA	4.194535
	10.87	053002309050	WHITEGIVER-SCHMITZ	NA	2.374872
	10.84	053002309060	WHITEGIVER-SCHMITZ	NA	2.375330
	10.78	053002309070	WHITEGIVER-SCHMITZ	NA	2.376210
	10.98	053002309085	RICHARD L ADAM	NA	4.190773
	11.05	053002309090	RICHARD L ADAM	NA	2.371405
	11.02	053002309100	CARL T AND KATHIE M ZETTERBERG	NA	2.371908
	10.98	053002309110	RICHARD L ADAM	NA	2.372513
	10.23	053002400000	MORY AND BARBARA HOUSHMAND	333	4.366455
	10.00	053002400050	MICHAEL J SCOTT	3	4.370927
	10.11	053002400150	GERHARD L AND MARY M HELLER	96	4.367875
	10.07	053002400200	WALTER CAMERON AND SANDRA WALKER	79	4.368632
	10.10	053002400300	AMY J GREENLIEF	67	4.368224
	10.44	053002400350	EVELYN M PLANT TTE	NA	2.400664
	10.32	053002400360	EVELYN M PLANT TTE	NA	2.401171
	10.13	053002400400	GARY AND JUDY GOODWIN	NA	4.367505

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Parcel Number (smallest to largest)	10.01	053002409010	PAUL ONOPIUK	49	4.370012
	10.06	053002409020	SMITH FAMILY TRUST	51	4.369479
	10.15	053002439000	R G AND MARGERY CROOK FAM TRUST	185	4.367188
	10.30	053002439010	BRIAN AND JANETH TOMLINSON	79	4.365335
	10.20	053002449000	TREADWELL FAMILY TRUST	237	4.366783
	13.54	053005400000	JOHN AND NINA PURCELL TTES	NA	4.163729
	13.54	053005400050	JOHN AND NINA PURCELL TTES	146	2.345175
	13.61	053005500040	JOSEPH T WANNER	1	4.163083
	13.59	053005500045	STEVE AND MIRJA WILSON	7	4.163190
	13.57	053005500050	CECIL C WHITE	26	4.163363
	13.57	053005500055	PHILLIP AND MARCIA LABOSSIERE	NA	2.344934
	13.60	053005500060	LANCE C AND CLAY J RICHMOND	275	2.344819
	13.52	053005510000	JANE S AND JAMES G PRYNE	349	2.345163
	13.54	053005510007	SANDRA BETTGER TTE	NA	2.345031
	13.41	053005510055	DONALD AND ROZELLA TRACHY JTWROS	370	2.345657
	13.39	053005510060	FREDRICK MERRIN AND SYLVIA LYNN SCHWYHART	286	2.345774
	13.42	053005510065	HALL SURVIVORS TRUST	NA	4.164086
	13.45	053005510070	ROBERTA J FISHER TTE	184	4.163848
	13.45	053005510075	LINDA ANN AND RICHARD THOMAS SMITH	286	2.345486
	13.48	053005510080	EARL AND PATRICIA BRUNNER	344	2.345354
	13.48	053005510085	DAVID J SALVETER	192	4.163725
	13.17	053008110000	GEORGE C RAINS SR LIVING TRST	NA	4.192373
	13.21	053008110100	JOHN R WEBB	NA	2.346314
	13.23	053008510000	ALVIN F OIEN ET AL TC	NA	2.346457
	13.26	053008510020	DAVID K AND MARIA S TEBOW	114	4.164653
	13.39	053008510030	RICHARD J SCHOENFELDT	1	4.164342
	13.18	053008510100	GEORGE C RAINS SR LIVING TRST	39	4.164928
	13.36	053008510400	RONALD AND CAROL BROWNING	302	2.345894
	13.34	053008510425	GEORGE H SCHOENFELDT	NA	2.346040
	13.32	053008510426	GEORGE H SCHOENFELDT	210	2.346048
	12.52	053009120252	NANCY J MCLAUGHLIN TTE	333	4.198720
	12.57	053009120270	DAVID M THOMPSON	NA	4.197748
	12.59	053009120350	JESSIE A AND SANDY L HYCHE	NA	4.197098
	12.27	053009140010	SYLVIA FEDER	NA	4.200249
	12.24	053009140020	JUDY L PALLAGI	54	4.200538
	12.21	053009140030	GEORGE E AND CATHERINE M LANHAM	91	4.200826
	12.12	053009140070	JOHN WARRICK AND RUTH JENKINS TTES	153	4.202101
	12.38	053009140100	JOHN WARRICK AND RUTH JENKINS TTES	NA	4.199300
	12.35	053009140120	JEANINE CARDIFF	209	4.199954
	12.65	053009140155	JOSEPH C BOWEN	NA	2.379846
	12.65	053009210000	BURT W REID	NA	4.196536
	13.14	053009221000	GEORGE C RAINS SR LIVING TRST	NA	4.194312
	12.88	053009231000	GEORGE C RAINS SR LIVING TRST	NA	2.376067

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Parcel Number (smallest to largest)	12.66	053009240000	ELISE GAGNON AND FRANKLIN J CATTON	NA	2.378249
	12.77	053009240050	JEFFERY L AND REBECCA CHEN	NA	2.377691
	12.80	053009240075	BURT W REID	NA	2.377125
	11.36	053010110000	FRED WAGNER	NA	2.397157
	12.09	053010230080	MICHAEL AND DINA OLSON	NA	4.202441
	12.04	053010230090	MICHAEL T AND D M OLSON	246	4.202780
	12.03	053010230105	JOHN WARRICK AND RUTH JENKINS TTES	NA	4.203118
	12.00	053010230110	JOHN WARRICK AND RUTH JENKINS TTES	68	4.203471
	11.98	053010230120	JOHN WARRICK AND RUTH JENKINS TTES	NA	4.203845
	11.94	053010230130	DON AND CHARLENE HENSLEE	NA	4.204221
	11.91	053010230140	DON AND CHARLENE HENSLEE	NA	4.204609
	11.88	053010550100	EDWIN C MURPHY	15	4.204799
	11.87	053010550102	SUE ELAINE RAINEY	33	4.204989
	11.84	053010550104	PETER A LAVELLE	87	4.205149
	11.84	053010550106	FERYDUN AND LAGHAIEH REZVANI TTE	NA	4.205336
	11.83	053010550108	LARRY D DOUGLAS	106	4.205517
	11.81	053010550110	CRAIG SMITH AND MARY HEFFERMAN	132	4.205883
	11.73	053010550120	GUENTHER HERZ TTE	68	4.206623
	11.70	053010550122	JOSEPH AND PAULINE PRETI TTES	81	4.206965
	11.69	053010550126	ROSS L CANNING	68	4.207146
	11.65	053010550128	ANDREW M AND JEANETTA J JOHNSON	101	4.207708
	11.65	053010550130	DONALD HILYARD AND G S LALONDE	NA	4.208055
	11.57	053010550135	DONALD HILYARD AND G S LALONDE	90	4.208809
	11.56	053010550138	JACK LEON LA FORGE	109	4.209002
	11.55	053010550140	ROBERT S BROWN	NA	4.209212
	11.88	053010550142	JOHN ALDEN MALMANGER	251	2.386793
	11.89	053010550144	JEFFREY A MILLER	NA	2.386736
	11.86	053010550182	PATRICIA L MILLER	294	2.386985
	11.84	053010550184	MICHAEL JOHN BERG	335	2.387355
	11.84	053010550185	JEFFREY A MILLER	313	2.387175
	11.81	053010550186	ANTHONY AND TERESA MARCHI	NA	2.387537
	11.79	053010550188	TERESA R MARCHI	326	2.387726
	11.78	053010550190	CHARLES J MILLER	325	2.387905
	11.77	053010550192	WILLIAM ISENBERG	323	2.388110
	11.72	053010550194	BARBARA K HORACEK TTE	309	2.388534
	11.71	053010550238	EUGENE J AND JO CAVANAGH	372	2.388737
	11.69	053010550240	THOMAS AND SHARON FRITSCHLER	378	2.388928
	11.68	053010550242	THOMAS AND SHARON FRITSCHLER	NA	2.389192
	11.64	053010550244	DONALD AND COLLEEN DALEY	320	2.389688
	11.62	053010550248	CHARLES E LEACH AND B A POZNANOVIC	316	2.389899
	11.61	053010550250	CHARLES E LEACH AND B A POZNANOVIC	NA	2.390100
	11.59	053010550252	MICHAEL AND ANN BUELL REVOCABLE TRUST	398	2.390314
	11.59	053010550254	KIMI HOYLE	NA	2.390585

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Parcel Number (smallest to largest)	11.55	053010550312	GLEN KOBATA	NA	2.391076
	11.56	053010550314	JOHN AND SANDRA STEPHENS	666	2.391301
	11.54	053010560100	EUGENE AND JEANNE BLAETTLER	73	4.209421
	11.52	053010560102	MILTON AND FAYRENE KENOYER	NA	4.209617
	11.51	053010560104	KAREN STEINMAUS	83	4.209823
	11.49	053010560106	KAREN STEINMAUS	NA	4.210019
	11.48	053010560108	JERRY A SCHNATTERLY	37	4.210225
	11.47	053010560110	JERRY A SCHNATTERLY	60	4.210437
	11.45	053010560112	MONTY AND SHERRY WEBB	NA	4.210641
	11.44	053010560115	MONTY AND SHERRY WEBB	67	4.211074
	11.41	053010560118	TONY I AND CONNIE J LITTLE	NA	4.211286
	11.40	053010560120	TONY I AND CONNIE J LITTLE	10	4.211473
	11.38	053010560122	ROBERT E AND E M BROWN	62	4.211672
	11.37	053010560124	ROBERT AND ROBIN BORDONARO	66	4.211892
	11.34	053010560126	STEVEN P BRIDGE	27	4.212099
	11.33	053010560128	KELLY PATRICK BURKE	15	4.212301
	11.33	053010560130	WILLIAM E AND JULIA ANN N GOTTHOLD TTES	14	4.212754
	11.29	053010560134	KEITH AND SANDRA L PATTISON TTES	66	4.212981
	11.28	053010560136	DEREK REED TTE	144	4.213250
	11.25	053010560138	JEFFREY A LITTELL	253	2.395353
	11.25	053010560140	RICHARD V AND PAMELA J EHTEE LIVING TRUST	422	2.395664
	11.19	053010560148	JOHN A LAYDEN	301	2.369182
	11.22	053010560150	ALICE CLARK	263	2.368802
	11.22	053010560152	ALICE CLARK AND MICHAEL BELL	NA	2.368514
	11.25	053010560155	RICHARD C AND MILDRED D JOHNSEN JOINT LIVING TRUST	84	4.186435
	11.22	053010560159	FEDERAL HOME LOAN MORT CORP	6	4.186835
	11.20	053010560162	STEPHEN D MULDER AND BETH E MULDER CO-TTE	34	4.187059
	11.19	053010560164	RAYMOND N AND C BRAUN	26	4.187304
	11.17	053010560166	RICHARD A AND PAULINE J CALLIS	49	4.187523
	11.16	053010560168	CLAIRE J AND BONNIE C GILSTAD TTES	32	4.187749
	11.15	053010560170	GARY E SJOROOS	45	4.187997
	11.14	053010560172	DAVID AND CECILIA COLBY	69	4.188228
	11.12	053010560174	JOHN AND VICKI L PASALICH	50	4.188471
	11.10	053010560176	JAMES AND PAMELA HARDIE	11	4.188826
	11.09	053010560178	NATALIE SPIEGEL	30	4.189103
	11.06	053010560180	M DAVIS ESTATE	15	4.189244
	11.10	053010560182	TARKY SUE PETERSEN AND ERIC C HEIM	323	2.370787
	11.14	053010560218	DENNIS/REGINA THOMASSEN	328	2.370191
	11.16	053010560220	CLAIRE J AND BONNIE C GILSTAD TTES	281	2.369810
	11.33	053010560244	TYLER J AND OLIVIA P AVERY	323	2.394453
	11.36	053010560246	ERICKSON LOGGING II LLC	NA	2.394188
	11.39	053010560249	JOHN M AND CHARMAYNE D HURLBUT	357	2.393677
	11.54	053010560334	LARRY D DOUGLAS	356	2.391395

	Drift Cell Miles	Parcel Number	Owner Name (Best available information as of May 2014)	Structure Years to Contact in 2012	Geophysical Score
Sorted by Parcel Number (smallest to largest)	11.50	053010560336	DONALD KRAUS	338	2.391769
	11.49	053010560338	GLEN KOBATA	NA	2.391972
	11.48	053010560340	LUIGI L NICOLOSO	313	2.392182
	11.46	053010560342	IRENE R SCHAFFNER	318	2.392605
	11.43	053010560346	THOMAS J LAROSA	314	2.392815
	11.42	053010560348	TONY I AND CONNIE J LITTLE	NA	2.393082
	11.79	053010570010	CHRISTOPHER D SAARI	19	4.206167
	11.76	053010570020	PHILIP K URATA	45	4.206442
	10.00	053011119000	HENRY AND SANDRA LEIS FAMILY REVOCABLE LIVING TRUST	NA	2.552284
	10.01	053011500000	BRIAN SCOTT AND HEATHER JANE STAMON	219	2.551578
	10.03	053011500100	ROBERT G ELLIS	253	2.550935
	10.05	053011500200	DAVID B CANTON AND NANCY L MAYER	432	2.550292
	10.07	053011500300	GARY R SWENSON	362	2.549651
	10.09	053011500400	RICHARD T AND DOROTHY A GRACE	580	2.549013
	8.94	053012110000	GREEN SPRINGS ASPEN LLC	NA	4.402302
	9.17	053012110100	EUGENE AND LINDA ANDERSON TTES	142	4.395241
	9.12	053012110125	ROY G AND CHERIE L BROWN TTES	80	4.397517
	8.97	053012110130	GREEN SPRINGS ASPEN LLC	NA	4.401704
	8.97	053012110135	DANIEL AND JANET ABBOTT	115	4.400873
	9.06	053012110145	DENNIS AND DIANE VENZON	72	4.398584
	9.20	053012119010	STANTON AND CAROL CREASEY	185	4.393101
	9.23	053012120000	BARBARA C DRENNAN	289	4.392101
	9.40	053012120125	SCOTT D AND GINGER L WIERZBANOWSKI	157	4.385284
	9.27	053012128010	JESSE H BLAKE	344	4.389895
	9.39	053012129030	CARLTON W AND BERNIECE E CLEVELAND TTES	216	4.386565
	9.33	053012129050	FLORENCE P HIGHTOWER TTE	116	4.387733
	9.45	053012500100	MARJORY GRAUE	NA	4.383824
	9.48	053012500125	MARJORY GRAUE	NA	4.382785
	9.64	053012500200	PACIFIC STAR INVESTMENTS LLC	182	4.379971
	9.67	053012500250	DW COLLIER CHARITABLE TRUST I AND W COLLIER FAM LLC	NA	4.378229
	9.67	053012500275	DOMAINE MADELEINE LLC	107	4.377649
	9.80	053012500300	MARY ANN HUDSON	6	4.374995
	9.90	053012500400	HEARST AND JERRI COEN REV LIVING TRUST	84	4.373916
	9.75	053012509240	CAPPY AND BETH ROTHMAN TTES	88	4.376654
	9.71	053012509250	CAPPY AND BETH ROTHMAN TTES	98	4.376809
	9.51	053012509450	PAUL D COOVER	134	4.381849
	9.72	053012509470	ANN WEINER	NA	2.557089
	9.78	053012509480	ANN WEINER	46	4.376007



Appendix D

North Olympic Land Trust Action Plan

February 2015

Appendix D: Conservation Tools for the Dungeness Drift Cell and Land Trust Priorities

February 18, 2015

Prepared by: The North Olympic Land Trust

Disclaimer:

The information contained herein was obtained from multiple origins, and the prioritization was generated from GIS data maintained by different sources and agencies. Results are based on best available data, but are not necessarily accurate to all applicable standards. Because of this, The Jamestown S'Klallam Tribe and North Olympic Land Trust do not retain any liability for the information contained herein. Additionally, this is a modeling exercise, and efforts have been made to correct any errors in the model, but all modeling exercises are inherently imperfect. Lastly, North Olympic Land Trust only works with willing sellers who voluntarily conserve their land.

Additional printed copies may be obtained from:

North Olympic Land Trust
104 N. Laurel Street, Suite 104
Port Angeles, WA 98362
Office: 360-417-1815

Preferred Citation:

North Olympic Land Trust and Jamestown S'Klallam Tribe. 2014. Dungeness Drift Cell Conservation Plan. Unpublished report. Port Angeles, WA.

Why is the Land Trust doing this work?

North Olympic Land Trust received a grant from the Puget Sound Acquisition and Restoration (PSAR) fund, through their Project Implementation and Development Award (PIDA).

The Land Trust wasn't sure of their role in the drift cell, with so many small parcels, but agreed to take on this work on behalf of the County. Throughout the process, the Land Trust has emphasized that this is not just a plan for the Land Trust and the Tribe. This is a plan for any conservation partner who can play a role in the conservation and restoration of the drift cell.

Prioritization:

The prioritization is detailed in the "Dungeness Drift Cell: Land Parcel Prioritization and Conservation Strategy", of which this is Appendix D.

The Tools, and Analysis of Land Trust priorities:

The Land Trust hired Erik Steffens to complete a report of the various tools to protect the sediment source of the Spit. Conservation easements and fee simple ownership are not a good fit for many of these parcels. That work was completed after numerous meetings with partners, including the Dungeness Wildlife Refuge, Trust for Public Lands, Clallam County, Coastal Watershed Institute, the Strait Ecosystem Recovery Network, Department of Natural Resources, Craft 3, Earth Economics, and the Jamestown S'Klallam Tribe.

When in quotations below, these are direct quotations from Erik Steffen's plan, a copy of which is at the Land Trust.

The main result is the following statement, taken from Erik's report: "While traditional conservation tools such as acquisition and conservation easements play a role in project implementation, it is important to note that the recommended overarching strategy is providing the landowners with the tools and resources they need to move structures away from the edge of the bluff."

Threatened Structures:

Using historic aerial photos and other data sources, the Tribe has collected erosion date. The average erosion rate of the bluff was determined to be around 1 ft/yr. Given this rate, all properties within 300 feet of the top of the bluff were included in the study area. This area was expected to be the source of sediment for at least the next 200 years. 282 parcels were part of this analysis after roads were removed, as well as some very small parcels. Roughly 60% of the properties are developed.

Total Parcels within 300' of Bluff Edge	282
Undeveloped	*116*
Developed	*166*

The analysis also identified immediate threat to existing houses by measuring its distance away from the edge of the bluff. Properties less than 15 feet from the bluff top are highly threatened and possibly could be undermined with one erosion event. Houses within 50 feet will be endangered within several decades. The analysis also looked at whether a property was large enough to allow existing structures to move back and relocate over 100' from the top of the bluff. The following table summarizes the results.

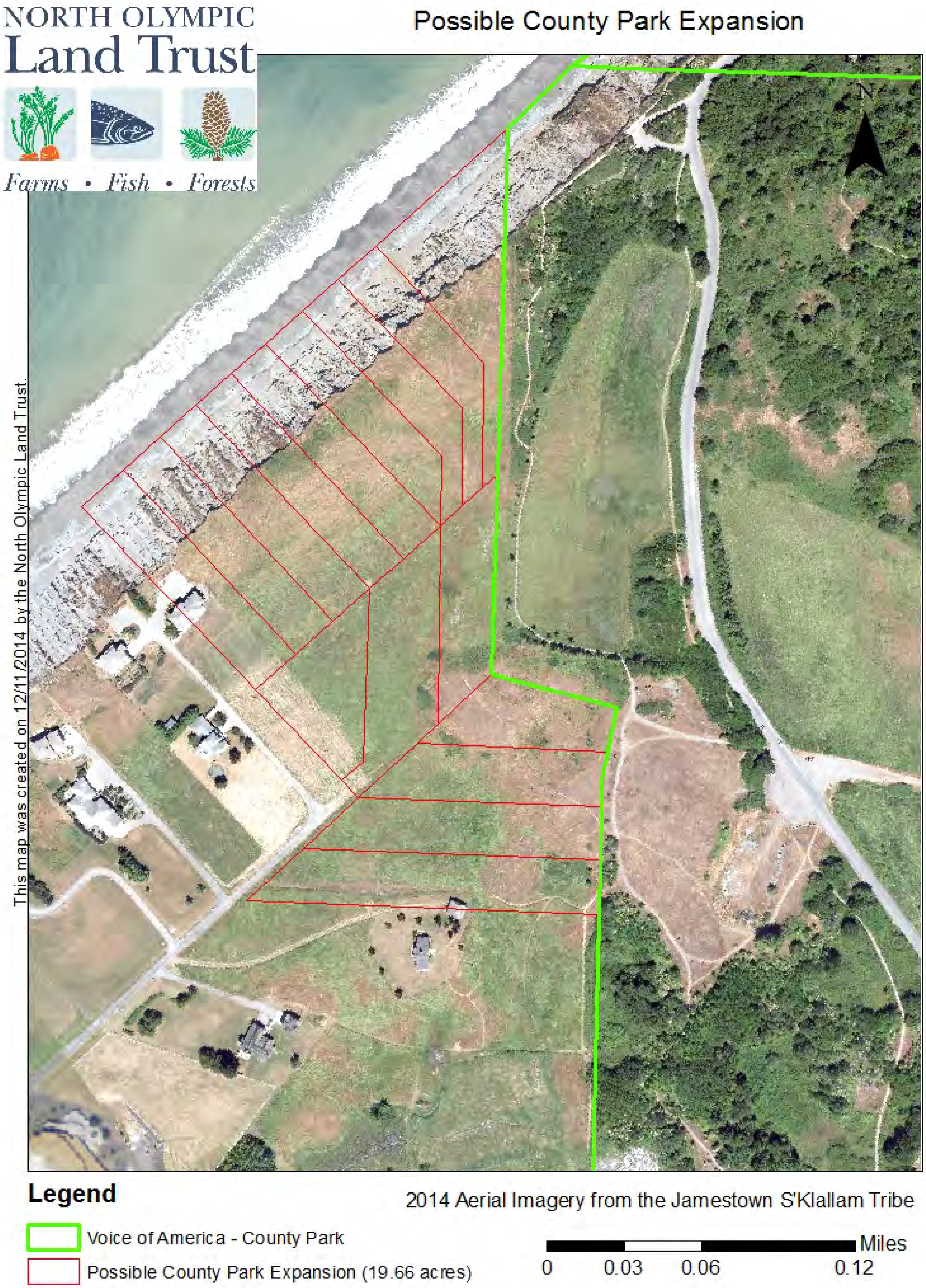
Highly Threatened Structures (15' of bluff edge)	~25
Threatened (within 50')	45
No Potential to Move Structures	47
Potential to Move Structures	52

Gradual Retreat Strategy: "Given the reality of continuing private ownership of the bluff, it's important to develop a conservation strategy which addresses how landowners can "retreat" away from the edge of the bluff, rather than try to stop erosion by armoring. This "gradual retreat" strategy requires a multi-dimensional approach to ensure that there are enough incentives to move back, as well as dis-incentives to armor. And, when the property is no longer safe, landowners have alternatives other than abandoning and letting the house fall over the bluff."

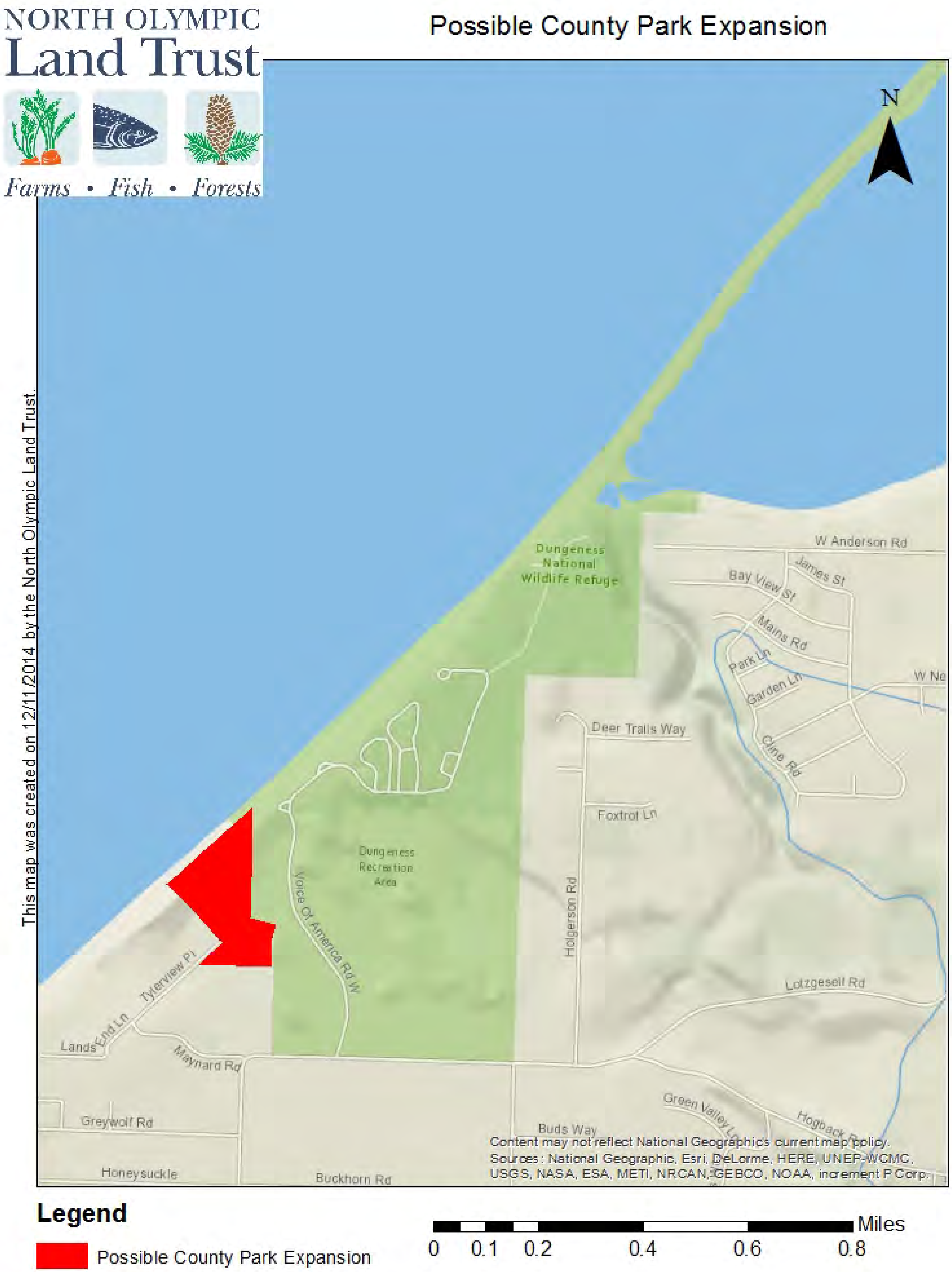
County Recreation Area Expansion: "Expansion of the Recreational Area has multiple conservation and recreation benefits and would likely rank well in several State and Federal grants. If this initial phase is accomplished the Recreation Area could continue to buy private land and expand further into the drift cell."

One landowner owns 19.66 acres, shown on the maps on the following pages. It is currently undeveloped, and includes ~ 1,200 feet of bluff frontage. Two maps below show the property. The first is a 2013 NAIP aerial image, and the second is a location map.

If this score's well with the Land Trust's current project selection criteria, this would likely be the Land Trust's highest priority project within this plan.


NORTH OLYMPIC
Land Trust
Farms • Fish • Forests
Possible County Park Expansion
N
This map was created on 12/11/2014 by the North Olympic Land Trust.
Legend
Voice of America - County Park
Possible County Park Expansion (19.66 acres)
2014 Aerial Imagery from the Jamestown S'Klallam Tribe
Miles
0
0.03
0.06
0.12

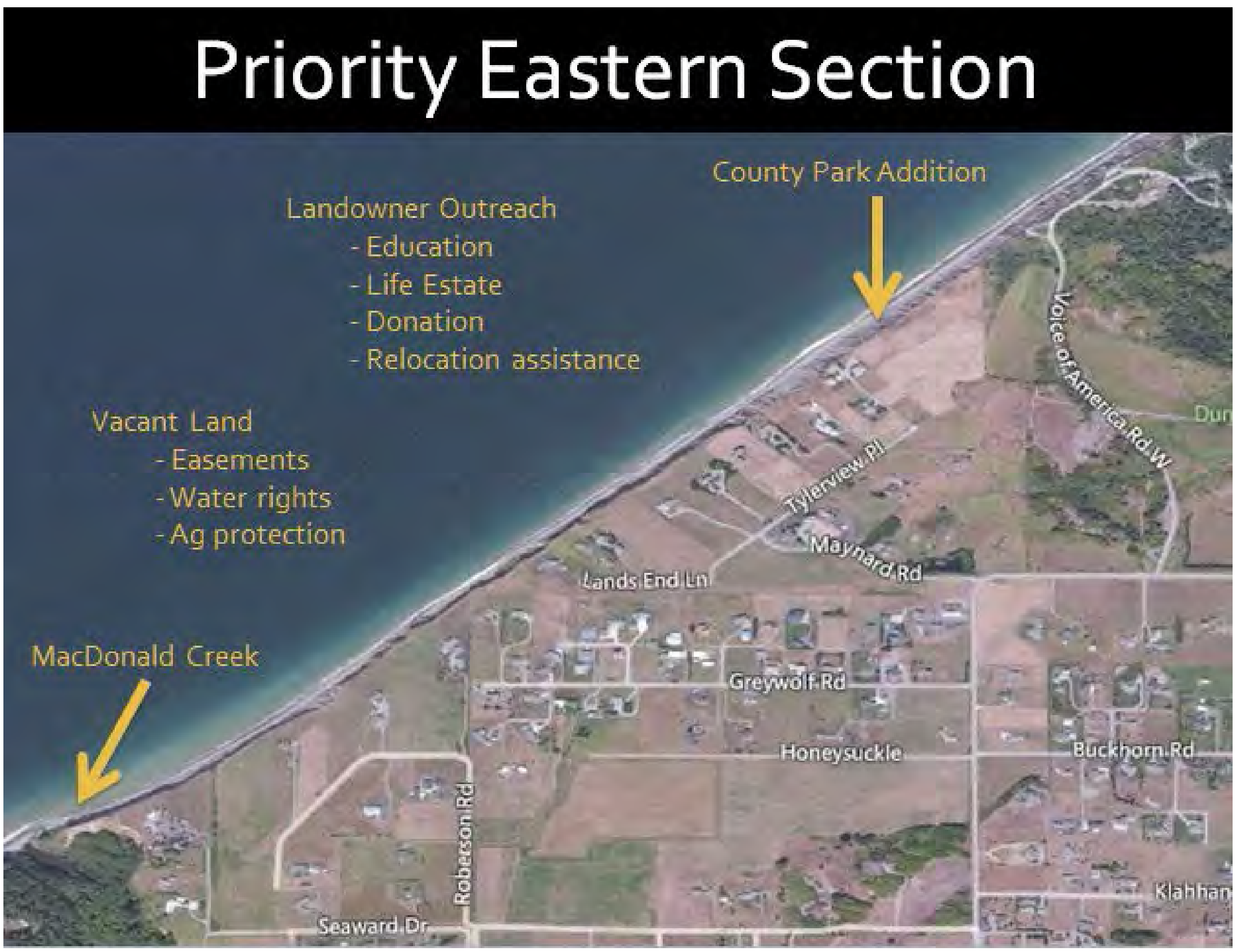
Possible County Park Expansion



Forested Parcels: "The Drift Cell contains several larger areas of undeveloped forested lots. These hold potential multiple shoreline recreation and conservation benefits and are potential candidates for acquisition funding sources. The Green Point area, the mouth of MacDonald Creek, and the forested block East of Morse Creek are all potential candidates for acquisition if the landowners are willing sellers."

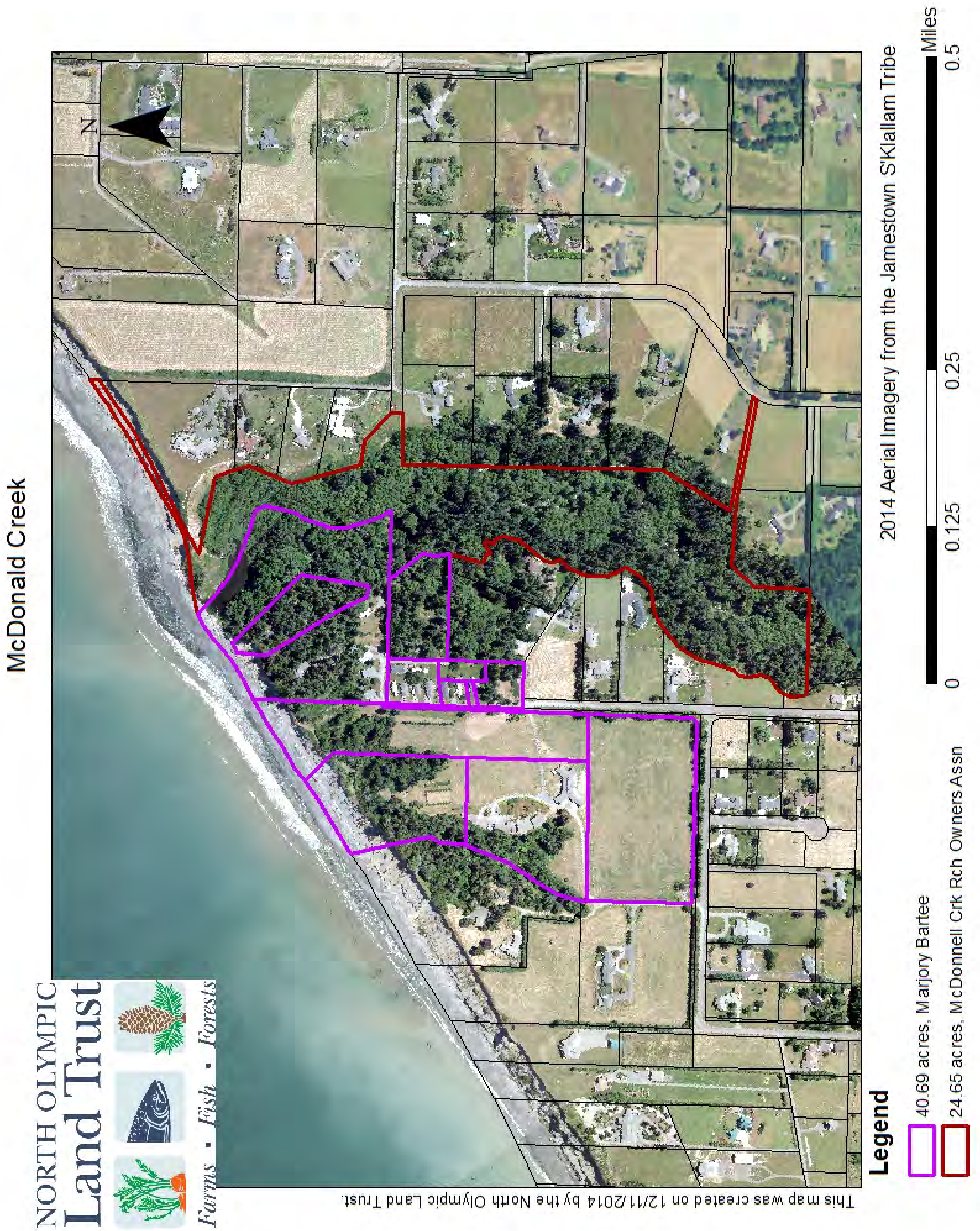
These are all projects that fit better with what we currently do than moving structures back. *If projects score well with the Land Trust's current project selection criteria, this would also be a high priority.*

There are a number of maps below of these possible projects.



Visual from Erik Steffen's presentation 9/11/14:


Green Point
NORTH OLYMPIC
Land Trust
Farms • Fish • Forests
N
Green Point
Legend
Clallam Parcels 20110810
NOLT NCED easements
2014 Aerial IUmagery from the Jamestown S'Klallam Tribe
0
0.05
0.1
0.2
Miles
This map was created on 12/11/2014 by the North Olympic Land Trust.


McDonald Creek
N
2014 Aerial Imagery from the Jamestown S'Klallam Tribe
Miles
0
0.125
0.25
0.5
Legend
40.69 acres, Marjory Bartee
24.65 acres, McDonnell Crk Rch Owners Assn
NORTH OLYMPIC
Land Trust
Farms • Fish • Forests
This map was created on 12/11/2014 by the North Olympic Land Trust.


East of Morse Creek
NORTH OLYMPIC
Land Trust
Farms • Fish • Forests
N
Rancho VERIP
Discovery Trail
2014 Aerial Imagery from the Jamestown S'Klallam Tribe
0
0.15
0.3
0.6
Miles
Legend
Morse Creek
NOLT NCED easements
Rains, 104.8 acres
Reid, 10.04 acres
Clallam_Parcels_20110810
This map was created on 12/11/2014 by the North Olympic Land Trust.

Donation, Life Estate and Lease back: "Many of the landowners along the bluff are of retirement age and purchased their properties to enjoy for their lifetime. There is likely a subset of landowners who would consider some sort of donation of their property, recognizing that the bluff is eroding and their investment is diminishing in value. ... The simplest approach would be a donation of property during the landowner's lifetime or as a bequest in a landowner's will. There is also the potential for the landowner to set up a Life Estate where the property transfers to the Land Trust upon the death of the landowner (or earlier). ...Another approach is for the Land Trust to purchase the property and lease the land back to the original landowner for a certain period of time."

Conservation Easement: "An easement could restrict some or all of the following rights to:

1) Armor the shoreline
2) Alter the bluff face
3) Build or maintain structures within a certain distance of the top of the bluff
4) Harvest trees and other vegetation within a certain distance of the top of the bluff."

"An easement can also be worded to move with the erosion of bluff. For example, The Nature Conservancy purchased an easement on a bluff on Camano Island."

"Using similar language, a possible scenario is purchasing an easement restricting any structures and armoring within 35 feet of the top of the bluff as it erodes."

What is the value of an easement that limits development of the property within 200 feet of the bluff, the time period of the Tribe's prioritization? "An easement which prevented any development on the property within 200 feet of the bluff top would force a landowner to build away from the amenities of an ocean front property (decreased views, sound of the waves, etc.) and closer to detracting qualities (proximity to road traffic, less privacy, etc.). Along the same lines, an easement that restricts housing to moveable structures such as RVs or Park Models would also greatly decrease the value of a property. In instances where a house already exists in a desired buffer and the property is large enough that the house could be relocated further back, there is the possibility of purchasing an easement, (e.g. 200' from the bluff) and providing the homeowner a limited time to move structures back. Such an easement is of considerable value, as described above, and is perhaps enough to cover the cost of moving the house back."

County-Wide Approaches

1) **Shoreline Management Program:** "The new plan would increase the level of protection of the feeder bluffs and strengthen the regulatory framework to base land use decisions upon throughout the County. The existing SMP allows bulkheading for single family residences in the project area under shoreline "Conservancy" designation."
2) **Conservation Futures:** The Conservation Futures Program consists of county-run acquisition programs that are empowered by the state government to raise funds for the conservation and maintenance of farmland, working forests, and open spaces through the purchase of easements, development rights, or acquisition of appropriate properties. A Conservation Futures Program is funded using a property tax levy of up to 6.25 cents per $1000 of assessed property value, or $12.50 per year for a $200,000 property.
3) **Transfer of Development Rights Program:** Transfer of Development Rights is a voluntary, incentive-based, and market-driven approach to preserve land and steer development growth away from rural and resource lands into urban areas. Clallam County has the legal framework in place to initiate a Transfer of Development (TDR) program.
4) **Current Use Taxation System:** "There is the possibility of reforming the open space classification to include lowered assessed rates for property owners who maintain a naturally vegetated shoreline. If enrolled a property owner would receive a lower property tax bill and would need to repay seven years of back taxes plus interest to remove the property from the program."
5) **Other Financing Mechanisms:** "Several other funding mechanisms worth considering are ones that could allow the County to set up funds specifically for buying distressed properties, or open space, moving endangered houses, and paying for continued management of bought properties. Funds could be collected from additional taxes on property owners or real estate transactions and could then be used to issue and sell tax exempt bonds. These included creation of a County Land Bank, Municipal or County bond measures and Special Assessment Districts or Lake Improvement Districts (LID). All of these require public support and are likely to face steep opposition over additional taxes and Government reach. Nevertheless, a small Lake Improvement District covering the project area could provide considerable benefit to homeowners along the bluff. The LID would first need to be designated by the County with the purpose of open space acquisition and management (e.g. buying and tearing down

condemned houses) and landowner assistance in securing low interest loans to move structures or tear downs. The LID would be a public entity with the ability to impose a special assessment on properties and issue public bonds, and also may be able to collectively bargain for lower rates for loans for house relocation or tear down. The pros and cons of creation of a LID would need to be discussed by the landowners in the project area and pursuing a LID would need to be fully supported by them."

Other Financing Incentives

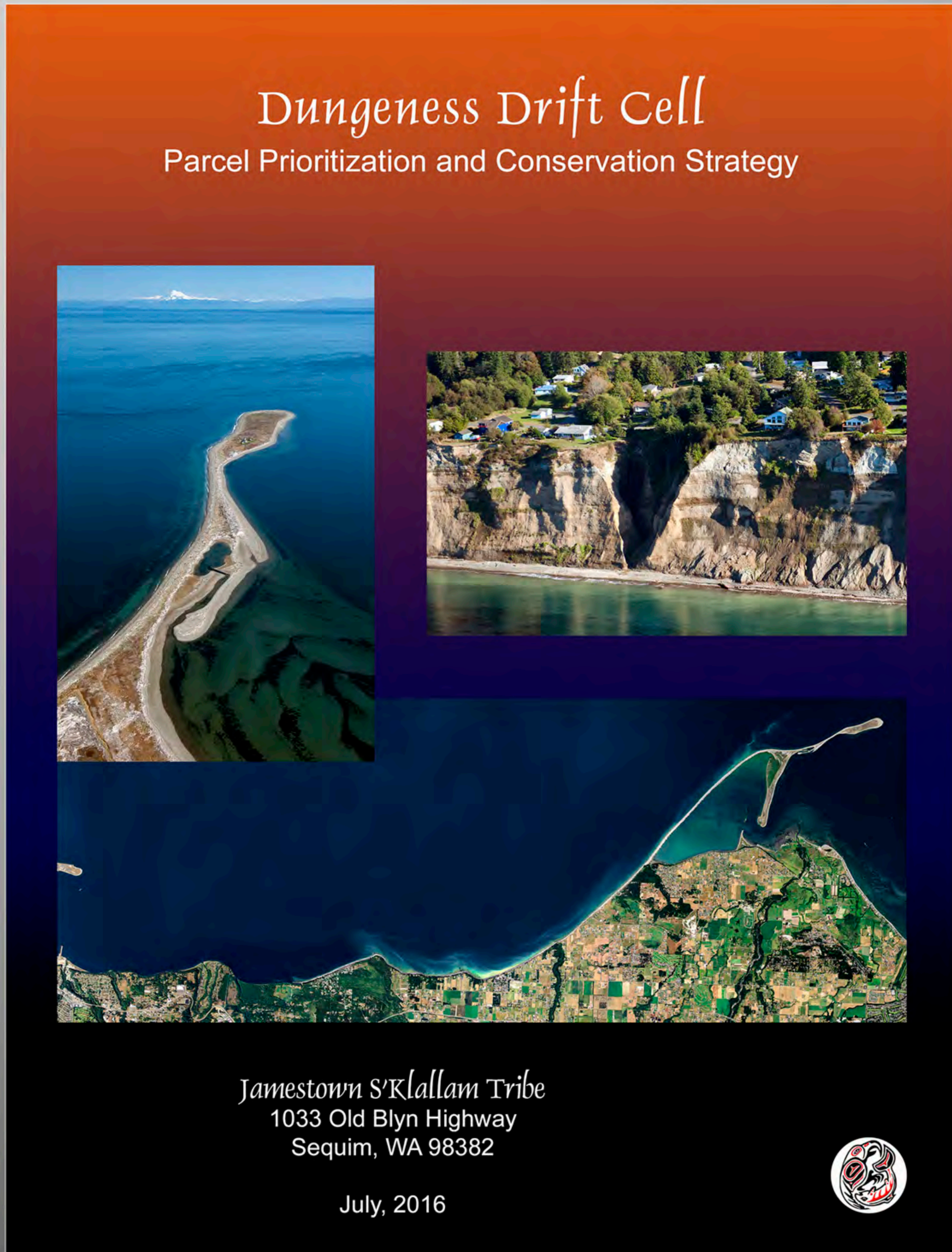
1) **House Relocation Assistance**: "Financing is a key component and access to a low or no interest loan would be a significant incentive to move structures back, and to do so sooner than before they are endangered."
2) **Teardown Assistance**: "There may be opportunities to work with non-conventional financing groups such as Craft3 especially if there are buyout programs in place."
3) "There are areas within the project area, particularly in the western portion, where there may be opportunities to buy several properties inexpensively and consolidate into larger lots with an easement preventing armoring and houses that are set back from the bluff. Selling these larger lots could generate profit, or at least break even, and ensure no future bulkheads"

Ecosystem services: "The revenue generated by tourism, private and commercial fishing is dependent on a functional spit. So there may be ways to generate income to insure that the system stays functional. Earth Economics and other partners have started researching this approach and may be able to develop ways to monetize the value of the continued function of the feeder bluffs."

Role of Dungeness National Wildlife Refuge: "The current role for the Dungeness National Wildlife Refuge is minimal given that the existing Refuge Boundary only includes the parcels currently owned by the Refuge. Refuge Staff and USFWS have no authority or mandate to operate outside of their borders. Nevertheless there is significant long-term potential to expand the refuge footprint and capacity to partner with organization and private landowners on work in the project area. The Refuge is a key player and could, in the future, have the ability to provide the stability and long-range vision for the entire drift cell, on which it depends. An example of a National Refuge which has such a plan is Turnbull Refuge in Eastern Washington. A special 44,000 acre "Stewardship Area" has been designated surrounding the Refuge."

Appropriate Tools for Property Types:

Property Types	Recommended Approaches
House on Small Lot	Acquisition Easement (If viable armoring threat) Financial incentives (loans, etc.) Donation Life Estate or Lease Back
Endangered House	Acquisition Financial incentives (relocation or tear down) Donation TDR
House on Large Lot	Easement Financial Incentives (house relocation) Acquisition Donation Life Estate or Lease Back
Vacant Land	Easement Acquisition Donation TDR



Appendix E

Parcel prioritization maps

2014 airphotos

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 1

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

Photo taken June 30, 2014

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 2

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

0 0.1 Miles

Photo taken June 30, 2014

N

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 3

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

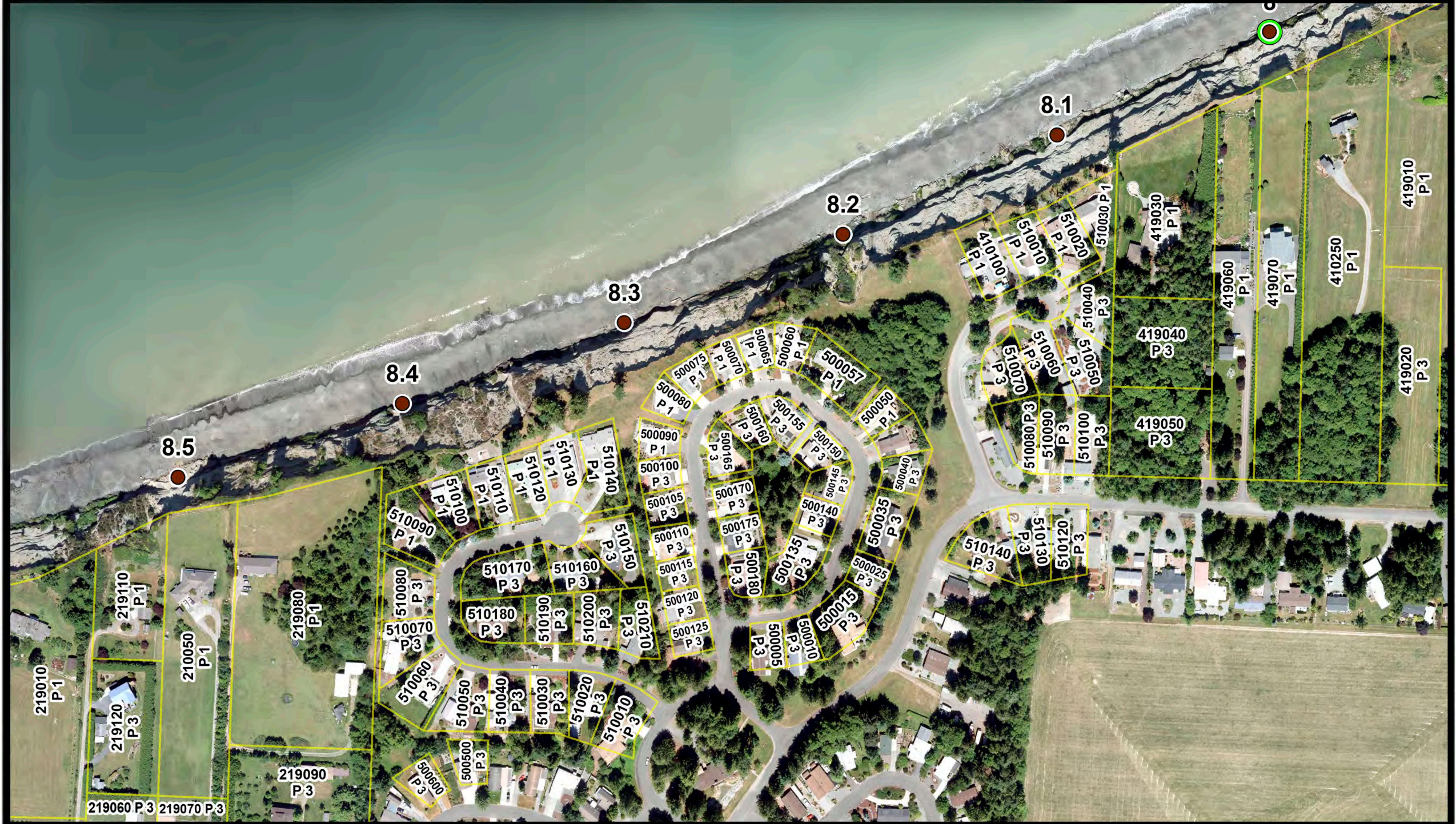
Photo taken June 30, 2014

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 4

0 0.1 Miles

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

Photo taken June 30, 2014 N



Dungeness Drift Cell Conservation Plan- Parcel Priority Map 5

0 — 0.08 Miles

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

Photo taken June 30, 2014 N

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 6

0 0.1 Miles

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

Photo taken June 30, 2014 N

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 7

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

Photo taken June 30, 2014

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 8

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

Photo taken June 30, 2014

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 9

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

0 0.1 Miles

Photo taken June 30, 2014 N

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 10

0 0.1 Miles

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

Photo taken June 30, 2014 N

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 11

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

Photo taken June 30, 2014

0 — 0.1 Miles

N

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 12

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

Photo taken June 30, 2014

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 13

0 — 0.1 Miles

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

Photo taken June 30, 2014

N

Dungeness Drift Cell Conservation Plan- Parcel Priority Map 14

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

0 0.1 Miles

Photo taken June 30, 2014 N

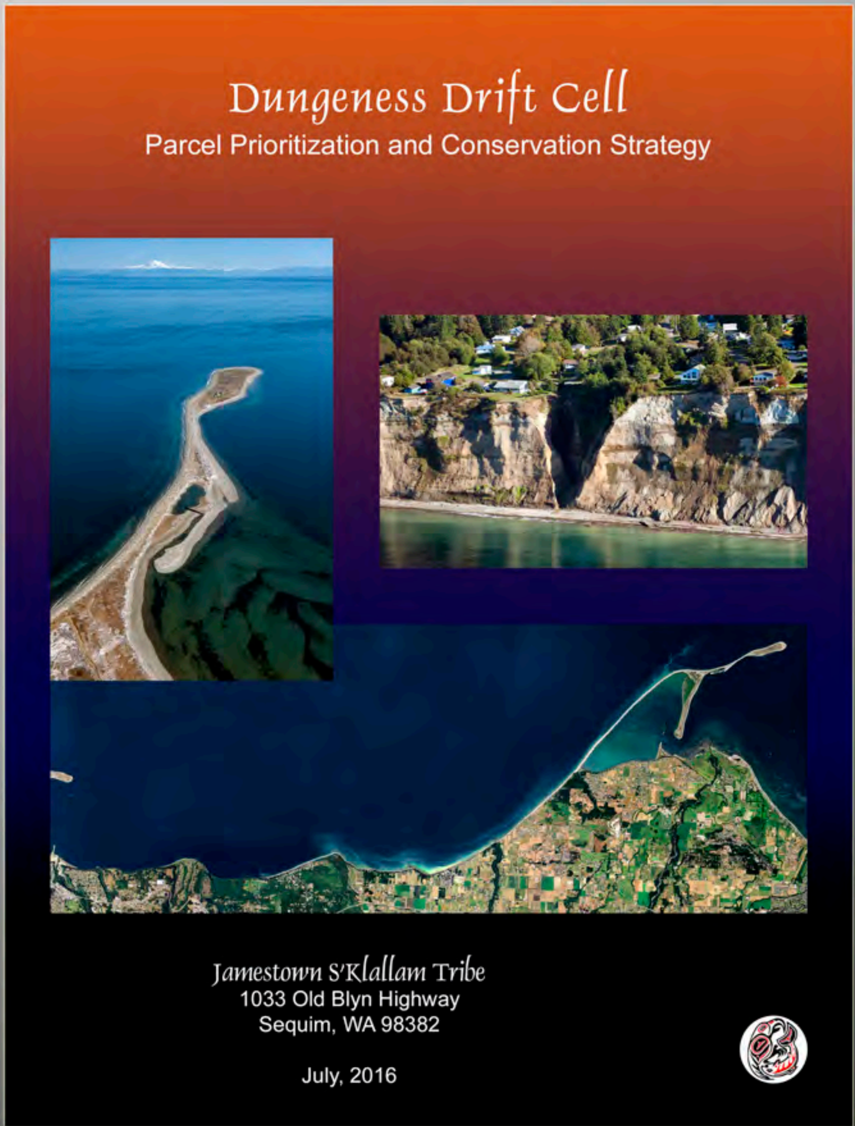
Dungeness Drift Cell Conservation Plan- Parcel Priority Map 15

0 0.1 Miles

Parcel boundaries (Yellow) modified from Clallam County 2010. Parcels are labeled with last six digits of the parcel number and with Priority (P) ranking. Drift Cell Miles are indicated at each maroon dot along the shoreline.

Photo taken June 30, 2014

N



Appendix F

2014 Oblique Bluff Photos with Drift Cell Miles

Dungeness Drift Cell

Drift Cell Mile (DCM) 0.0 to 5.0

Photo Date 05/04/2013


DCM 0.0
DCM 1.0
DCM 2.0
DCM 3.0
DCM 4.0
DCM 5.0

Drift Cell Mile (DCM) 5.0 to 5.35

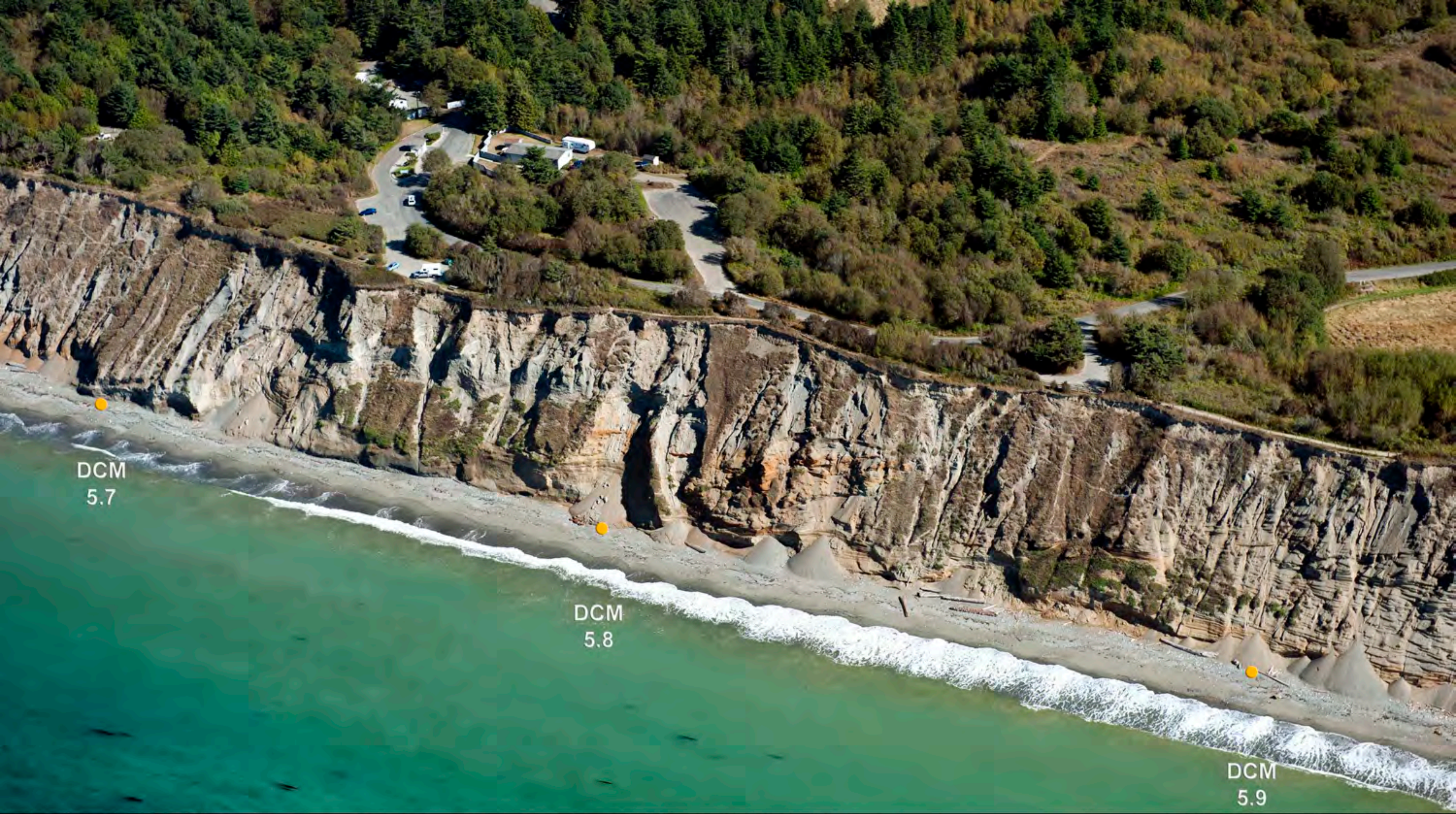
Photo Date
9/10/2013


DCM
5.2
DCM
5.3
DCM
5.4
DCM
5.47

Drift Cell Mile (DCM) 5.3 to 5.54

Photo Date
9/10/2013


DCM
5.5
DCM
5.6
DCM
5.7


DCM
5.7
DCM
5.8
DCM
5.9


DCM
5.8
DCM
5.9
DCM
6.0


DCM
5.96
DCM
6.0
DCM
6.1
DCM
6.2


DCM
5.97
DCM
6.0
DCM
6.1
DCM
6.15

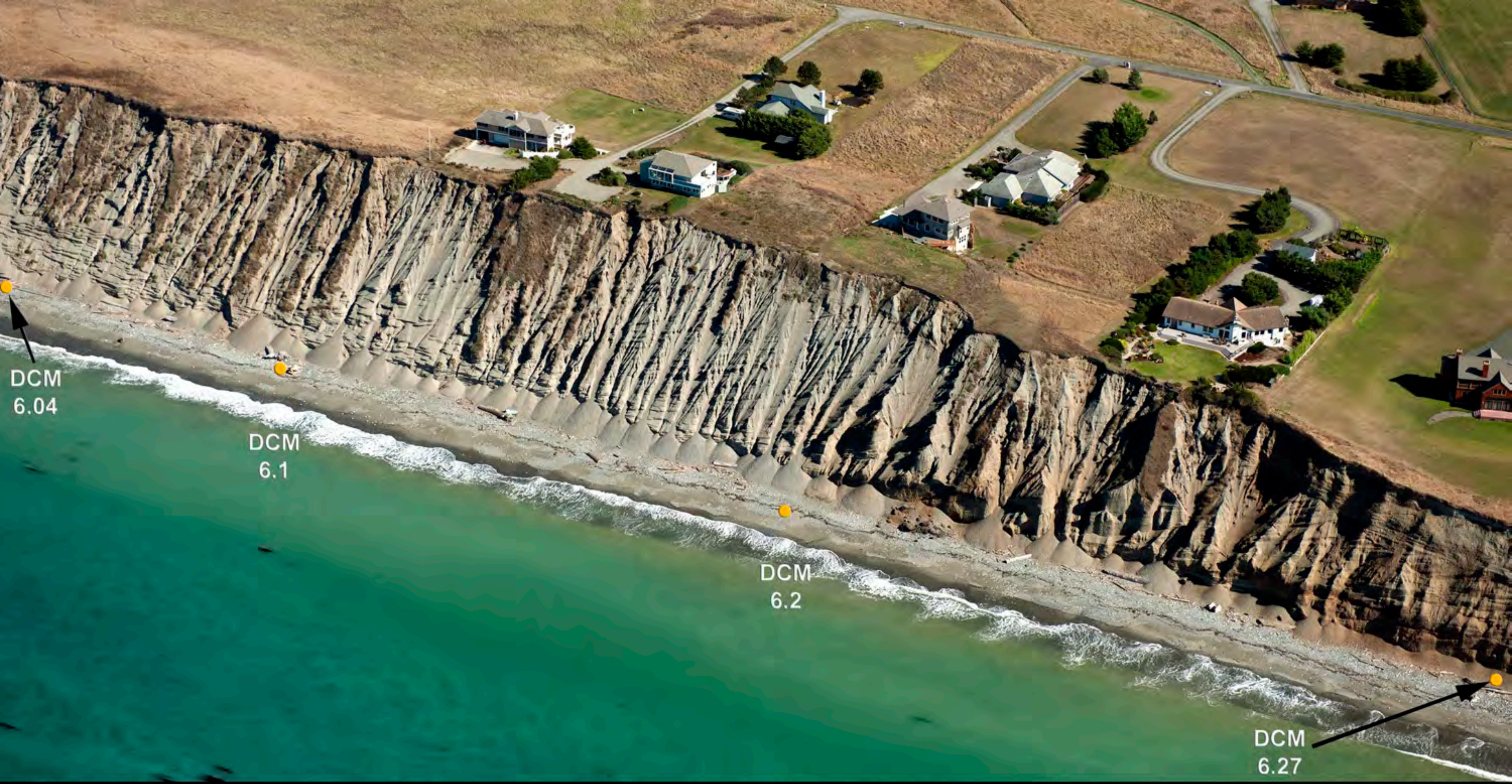


Photo Date
9/10/2013


DCM
6.22
DCM
6.3
DCM
6.4

Drift Cell Mile (DCM) 6.29 to 6.51

Photo Date
9/10/2013

Drift Cell Mile (DCM) 6.45 to 6.62

Photo Date
9/10/2013

Dungeness Drift Cell

Drift Cell Mile (DCM) 6.45 to 6.69

Photo Date
9/10/2013

 Drift Cell Mile (DCM) 6.61 to 6.81 Photo Date 9/10/2013

Drift Cell Mile (DCM) 6.78 to 6.95

Photo Date
9/10/2013

Photo Date
9/10/2013


DCM
6.95
DCM
7.0
DCM
7.1
McDonald Creek
DCM
7.2

Dungeness Drift Cell

Drift Cell Mile (DCM) 7.16 to 7.45

Photo Date
9/10/2013

DCM
7.3
DCM
7.4
DCM
7.5
DCM
7.6


DCM
7.5
DCM
7.6
DCM
7.66

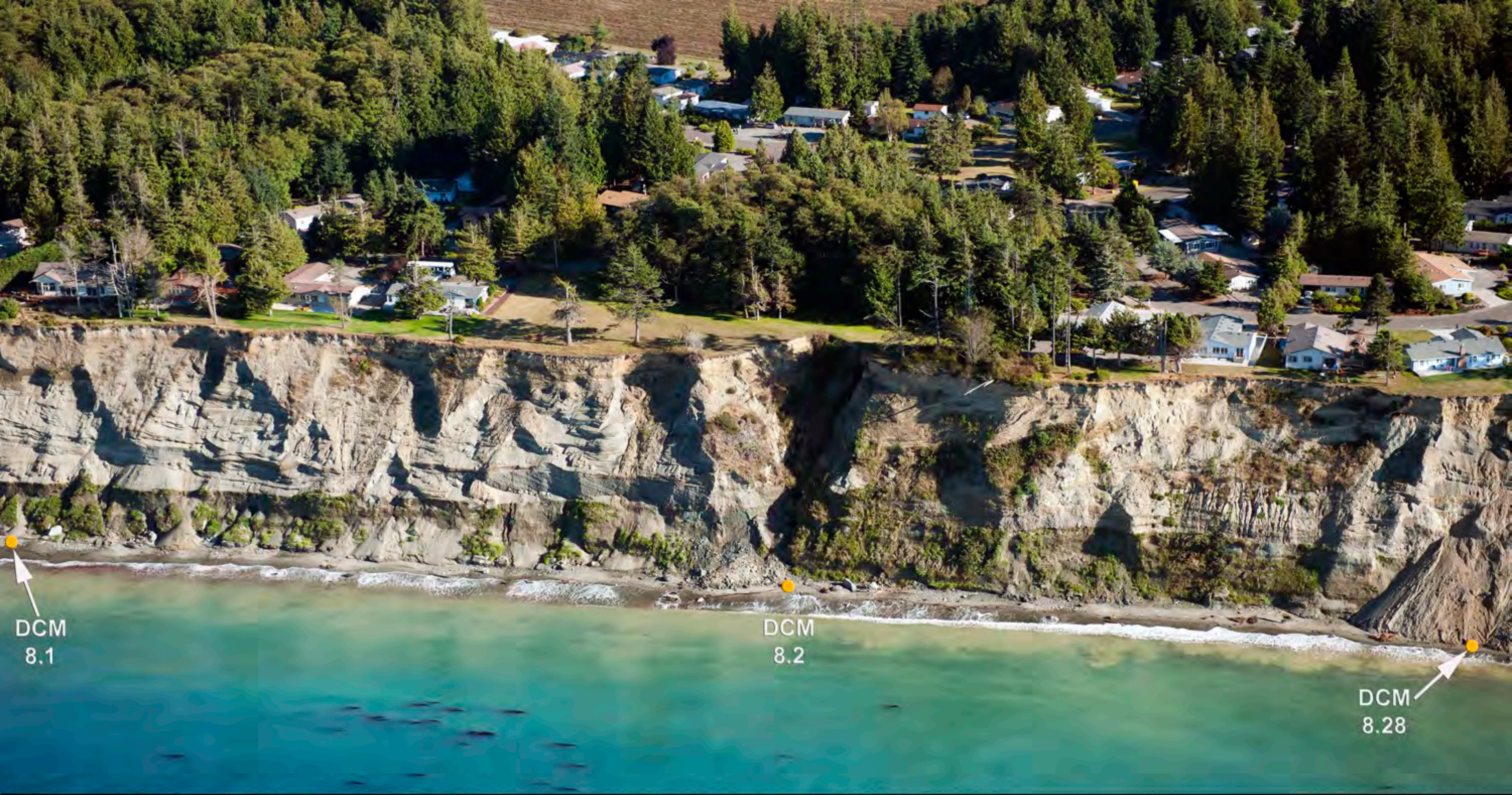

DCM
7.5
DCM
7.6
DCM
7.7
DCM
7.8


DCM
7.72
DCM
7.8
DCM
7.89


DCM
7.82
DCM
7.9
DCM
8.0

Drift Cell Mile (DCM) 7.96 to 8.14

Photo Date
9/10/2013



Dungeness Drift Cell

Drift Cell Mile (DCM) 8.1 to 8.28

Photo Date
9/10/2013

Dungeness Drift Cell

Drift Cell Mile (DCM) 8.2 to 8.39

Photo Date
9/10/2013


DCM
8.3
DCM
8.4
DCM
8.5

Dungeness Drift Cell

Drift Cell Mile (DCM) 8.41 to 8.62

Photo Date
9/10/2013


DCM
8.61
DCM
8.7
DCM
8.8
DCM
8.9

Dungeness Drift Cell

Drift Cell Mile (DCM) 8.63 to 9.02

Photo Date 9/10/2013

Drift Cell Mile (DCM) 8.93 to 9.2

Photo Date
9/10/2013

Dungeness Drift Cell

Drift Cell Mile (DCM) 9.03 to 9.21

Photo Date
9/10/2013

Drift Cell Mile (DCM) 9.06 to 9.33

Photo Date
9/10/2013

Dungeness Drift Cell

Drift Cell Mile (DCM) 9.28 to 9.5

Photo Date
9/10/2013

Dungeness Drift Cell

Drift Cell Mile (DCM) 9.46 to 9.67

Photo Date
9/10/2013

Dungeness Drift Cell Drift Cell Mile (DCM) 9.55 to 9.86 Photo Date 9/10/2013

Drift Cell Mile (DCM) 9.61 to 9.85

Photo Date
9/10/2013

Dungeness Drift Cell

Drift Cell Mile (DCM) 9.73 to 10.0

Photo Date
9/10/2013

Dungeness Drift Cell

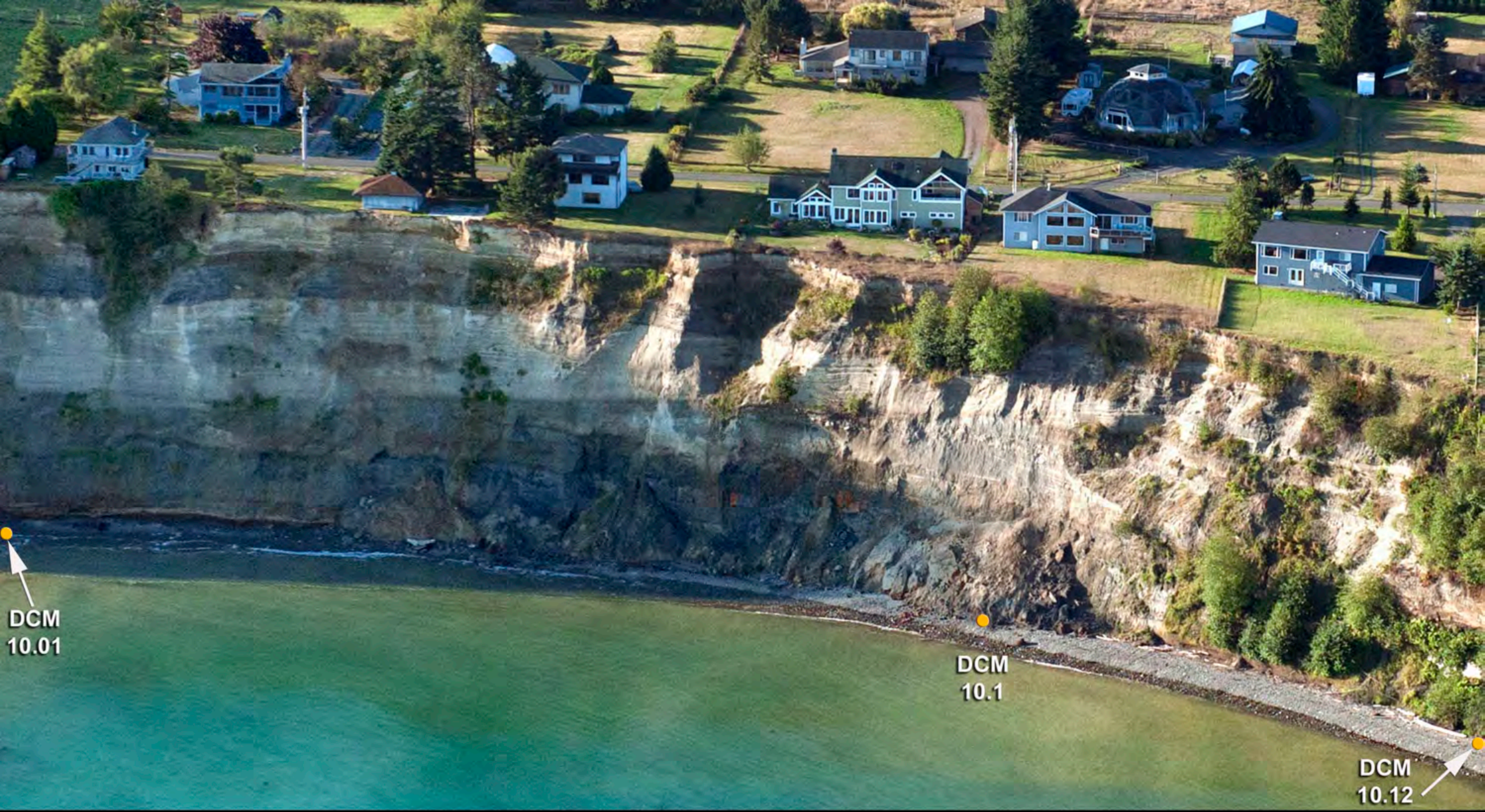
Drift Cell Mile (DCM) 9.95 to 10.24

Photo Date
9/10/2013


DCM
9.96
DCM
10.0
DCM
10.1
DCM
10.15

Drift Cell Mile (DCM) 10 to 10.34

Photo Date
9/10/2013


DCM
10.01
DCM
10.1
DCM
10.12

Drift Cell Mile (DCM) 10.2 to 10.65

Photo Date
9/10/2013


DCM
10.4
DCM
10.5
DCM
10.6
DCM
10.7
DCM
10.76

Dungeness Drift Cell

Drift Cell Mile (DCM) 10.73 to 11.04

Photo Date
9/10/2013


DCM
10.85
DCM
10.9
DCM
11.0
DCM
11.1
DCM
11.16

Dungeness Drift Cell

Drift Cell Mile (DCM) 11.08 to 11.39

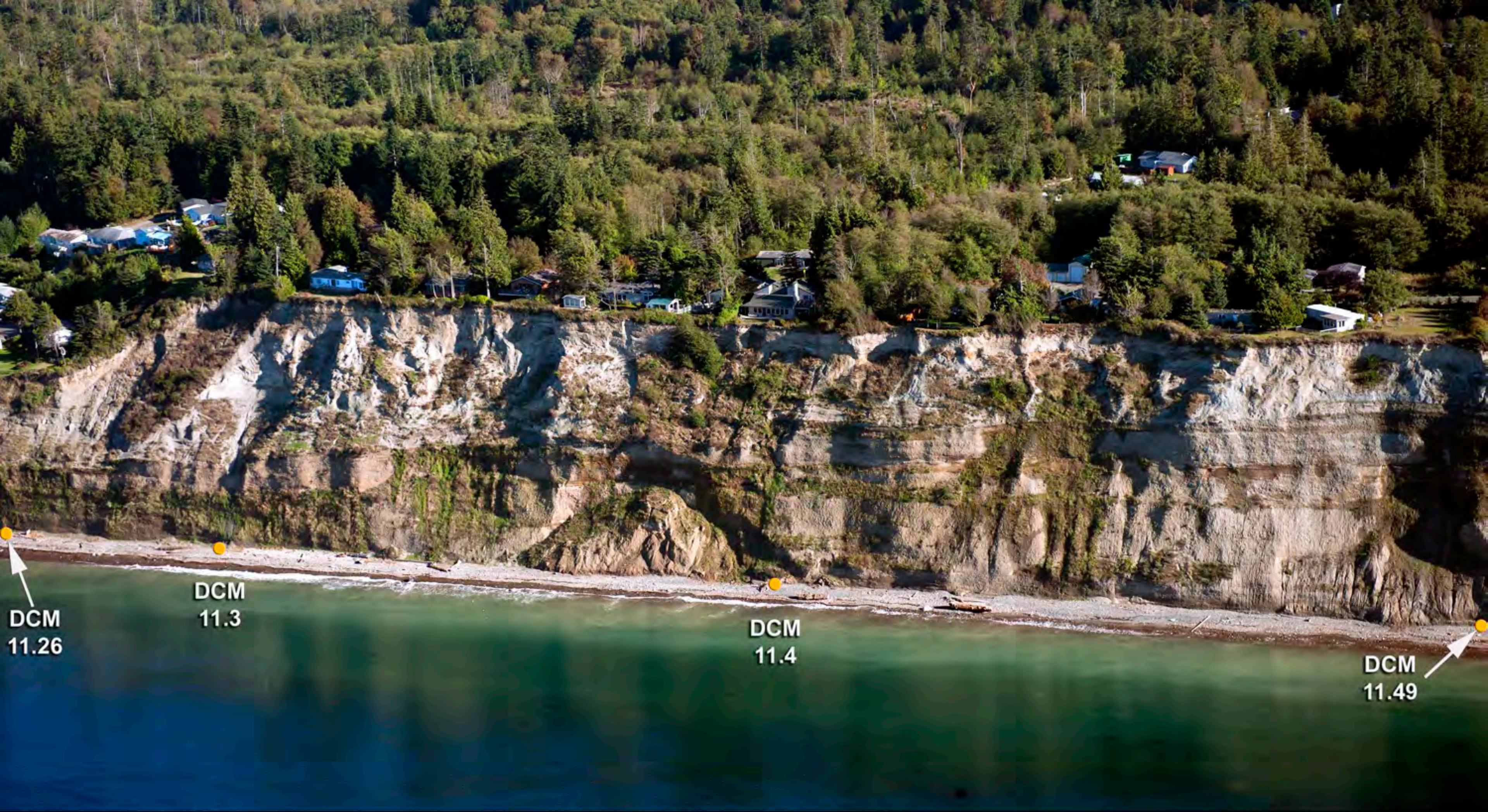
Photo Date
9/10/2013

Dungeness Drift Cell Drift Cell Mile (DCM) 11.13 to 11.43 Photo Date 9/10/2013

Dungeness Drift Cell

Drift Cell Mile (DCM) 11.20 to 11.42

Photo Date
9/10/2013



Drift Cell Mile (DCM) 11.26 to 11.49

Photo Date
9/10/2013

Dungeness Drift Cell

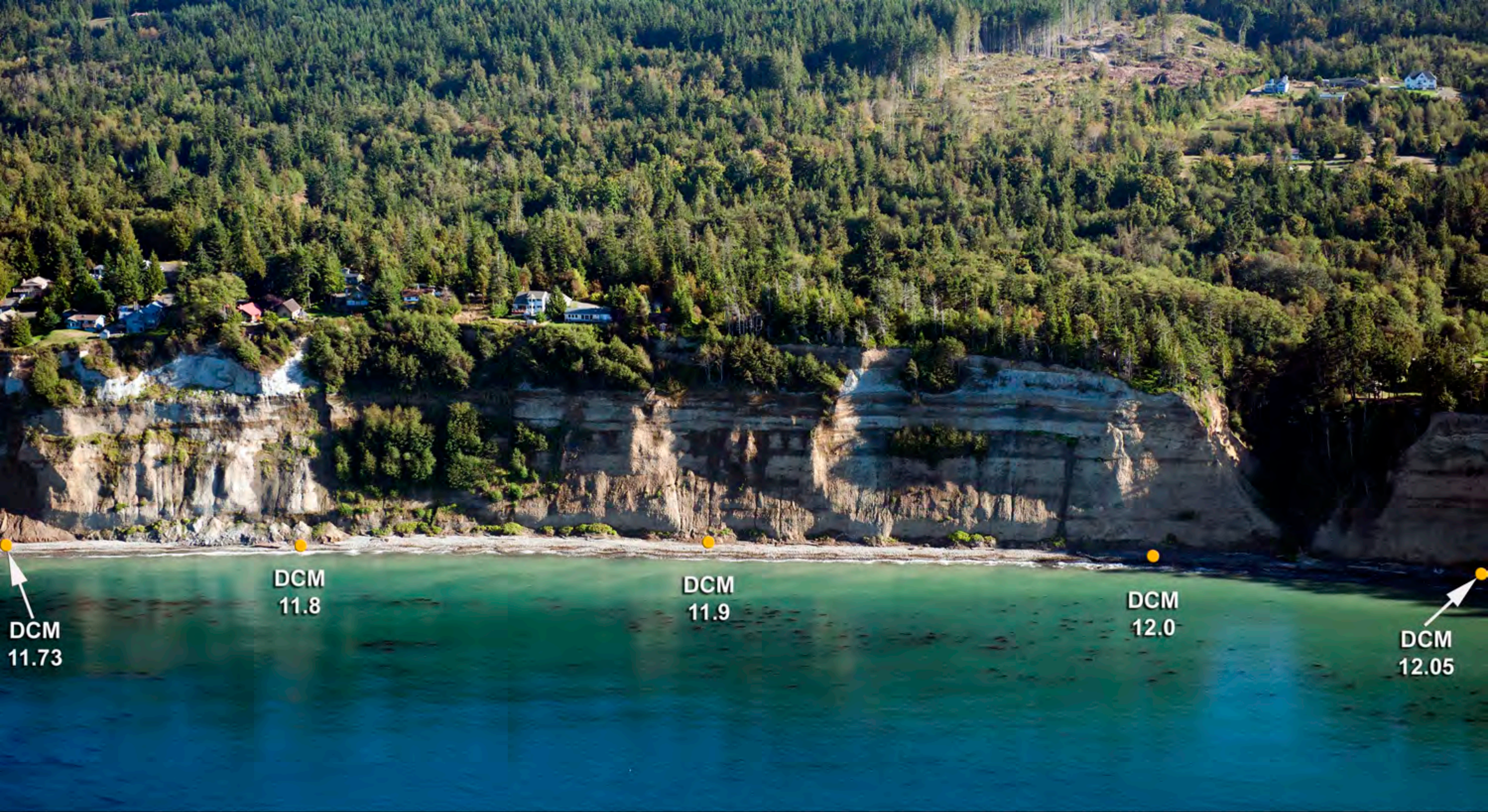
Drift Cell Mile (DCM) 11.48 to 11.81

Photo Date 9/10/2013

Dungeness Drift Cell

Drift Cell Mile (DCM) 11.58 to 11.92

Photo Date
9/10/2013



Dungeness Drift Cell

Drift Cell Mile (DCM) 11.73 to 12.05

Photo Date
9/10/2013


DCM
11.92
DCM
12.0
DCM
12.1
DCM
12.15

Drift Cell Mile (DCM) 12.04 to 12.38

Photo Date
9/10/2013

Drift Cell Mile (DCM) 12.15 to 12.4

Photo Date
9/10/2013

Dungeness Drift Cell Drift Cell Mile (DCM) 12.32 to 12.64

Photo Date
9/10/2013

Dungeness Drift Cell

Drift Cell Mile (DCM) 12.5 to 12.84

Photo Date
9/10/2013

Dungeness Drift Cell

Drift Cell Mile (DCM) 12.75 to 13.15

Photo Date
9/10/2013


DCM
12.96
DCM
13.0
DCM
13.1
DCM
13.2

Dungeness Drift Cell

Drift Cell Mile (DCM) 12.98 to 13.42

Photo Date
9/10/2013

Drift Cell Mile (DCM) 13.06 to 13.33

Photo Date
9/10/2013

Dungeness Drift Cell Drift Cell Mile (DCM) 13.15 to 13.66 Photo Date 9/10/2013

Dungeness Drift Cell

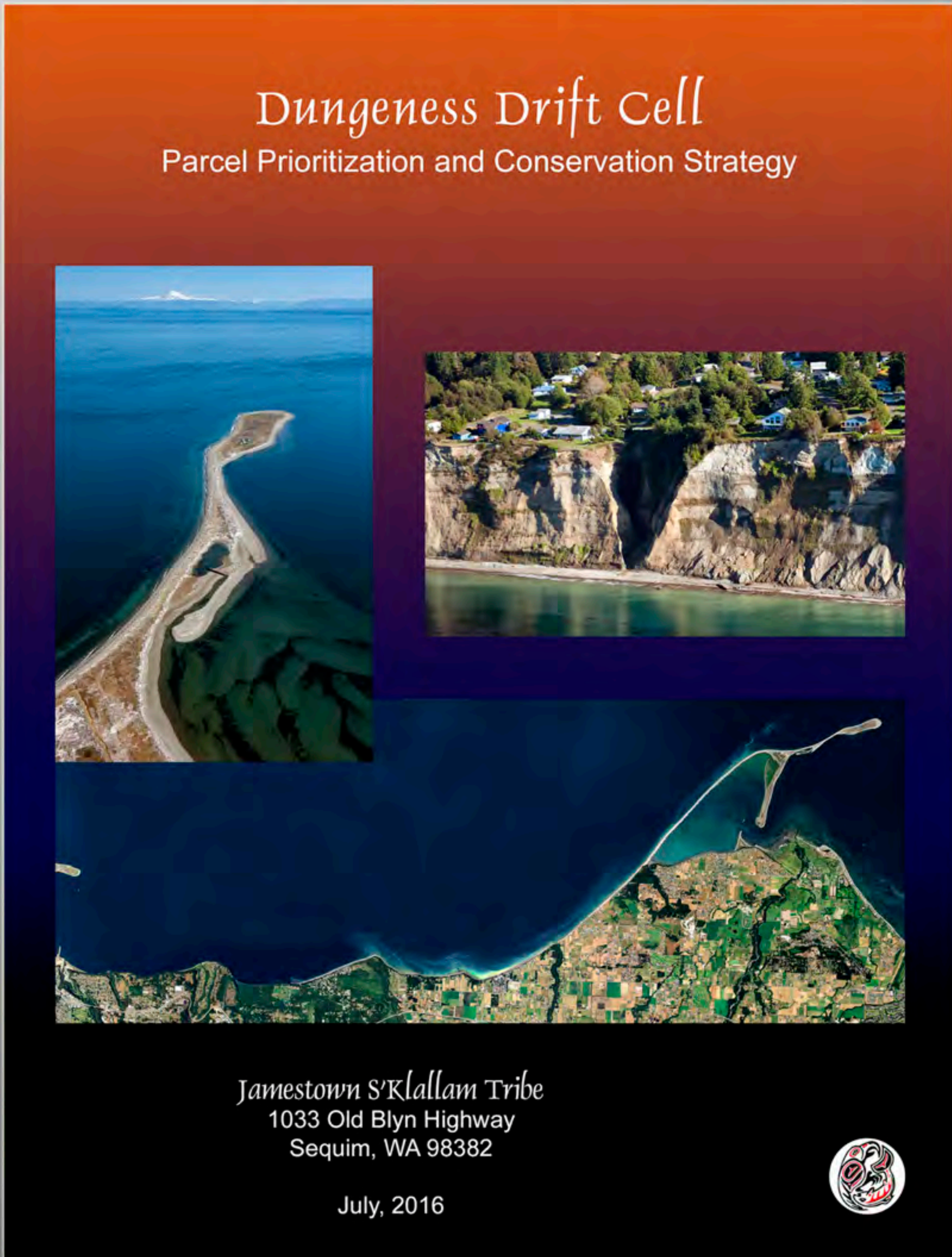
Drift Cell Mile (DCM) 13.24 to 13.56

Photo Date
9/10/2013

Dungeness Drift Cell

Drift Cell Mile (DCM) 13.65 to 14.07

Photo Date
9/10/2013



Dungeness Drift Cell

Parcel Prioritization and Conservation Strategy

Jamestown S'Klallam Tribe
1033 Old Blyn Highway
Sequim, WA 98382

July, 2016

Appendix G

Estimates of Feeder Bluff Recession Rates in the Dungeness Spit Drift Cell, Clallam County, Washington

Estimates of Feeder Bluff Recession Rates in the Dungeness Spit Drift Cell, Clallam County, Washington

Robert Knapp and Randy Johnson, Jamestown S'Klallam Tribe, July 2016

Contents

Introduction

Dungeness Spit, located on the north Olympic Peninsula in Clallam County, Washington [Figure 1), is a 5-mile long natural sand spit that curves gracefully from the base of a high bluff to a sandy point several miles offshore in the Strait of Juan de Fuca. A half mile from the end of the Spit stands the historic New Dungeness Lighthouse, built in 1857. The Spit is protected as a National Wildlife Refuge and is a major recreational destination for hiking, birding, wildlife watching, and other passive beach activities.

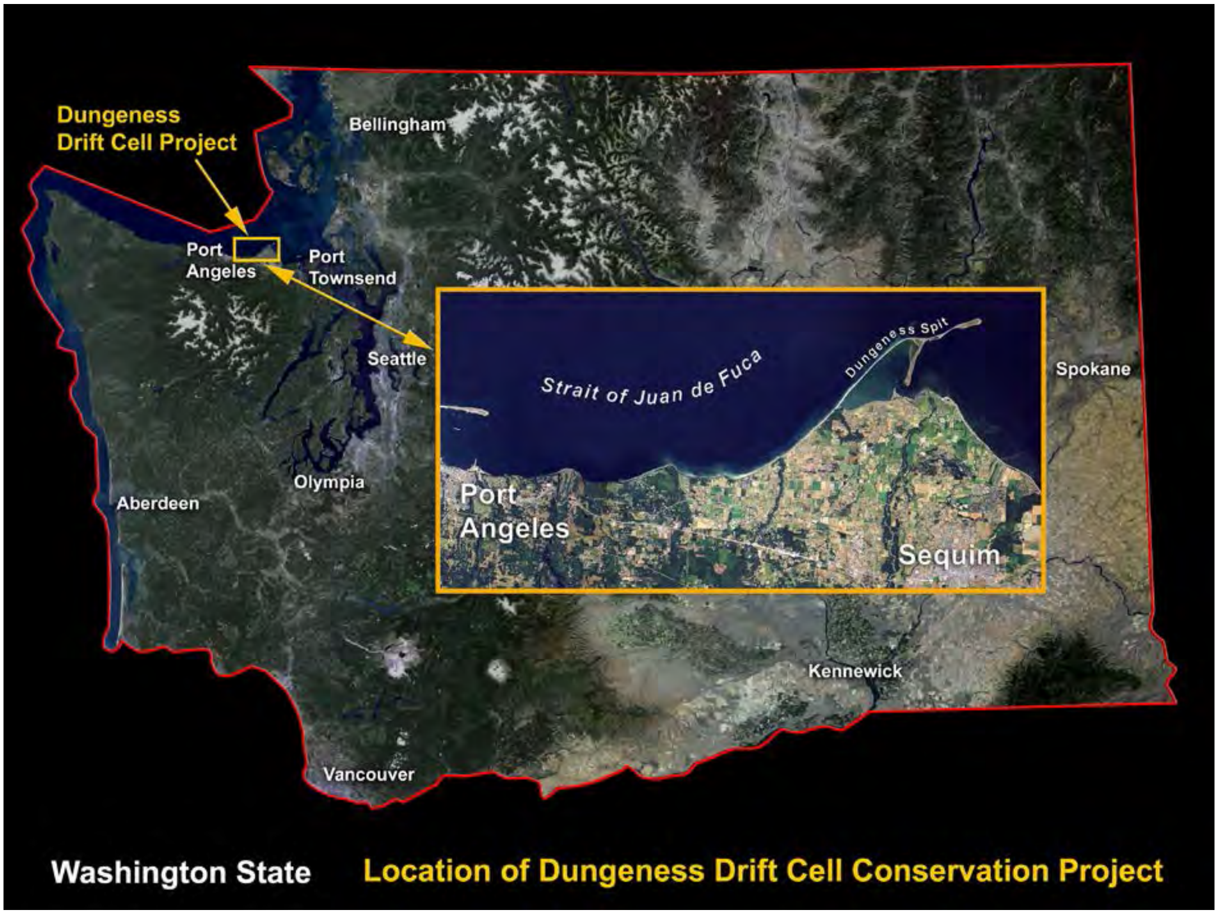


Figure 1: Olympic Peninsula

Dungeness Spit creates the 5.7-square mile Dungeness Bay, within which are two additional spits, Graveyard Spit, and Cline Spit. These two spits almost completely enclose Inner Dungeness Bay, which accounts for about one-third of the total size of the Bay. The portion of Dungeness Spit extending east beyond Graveyard Spit creates the larger Outer Bay (See Figure 2).

Together, the three spits protect the dynamic and habitat-rich estuary of the Dungeness River. Within Dungeness Bay there are marshes, eelgrass beds, tidal flats, and a small lagoon. These estuarine areas are important habitat for migratory and resident birds, wildlife, and fish, including endangered salmon and char. Dungeness Spit and the habitat within Dungeness Bay are of special importance to the Jamestown S'Klallam Tribe for their cultural and natural resource values.

Figure 2: Dungeness, Cline, Graveyard Spits mostly enclose the Inner Dungeness Bay, also called Dungeness Harbor. Dungeness Spit extends and continues to grow beyond Graveyard Spit, partially protecting the Outer Dungeness Bay. Imagery NAIP 2013.

Few visitors to Dungeness Spit realize that the high bluffs that form the shoreline extending 10.5 miles westward are an essential part of the geologic feature that culminates at the Spit. Eroding sand and gravel from the bluffs, swept alongshore by currents, wind, and waves, have created the Spit and continue to maintain it. Without the sediment eroded from the bluffs, Dungeness Spit would disappear, either gradually in the waves, or suddenly in a major storm.

The Spit acts as a barrier to waves generated by westerly winds and thereby protects homes and recreational developments that cluster along the shoreline several miles to the east and southeast. Without Dungeness Spit, the heavily developed bluffs bordering the sheltered Dungeness Bay would likely begin eroding at rates similar to those observed along the bluffs to the west that are open to the Strait. And without the Spit, the low-lying shorelines farther east– Rivers End and Three Crabs Road – would probably begin eroding at catastrophically high rates.

Within the Dungeness Wildlife Refuge federal laws protect Dungeness Bay and the Spit from development and incompatible uses. Outside the Refuge, various local, state, and federal regulations exist to conserve shorelines and protect fish habitat. These regulatory programs however are replete with exemptions that severely diminish their ability to ensure that the sediment sources for Dungeness Spit will be perpetually conserved.

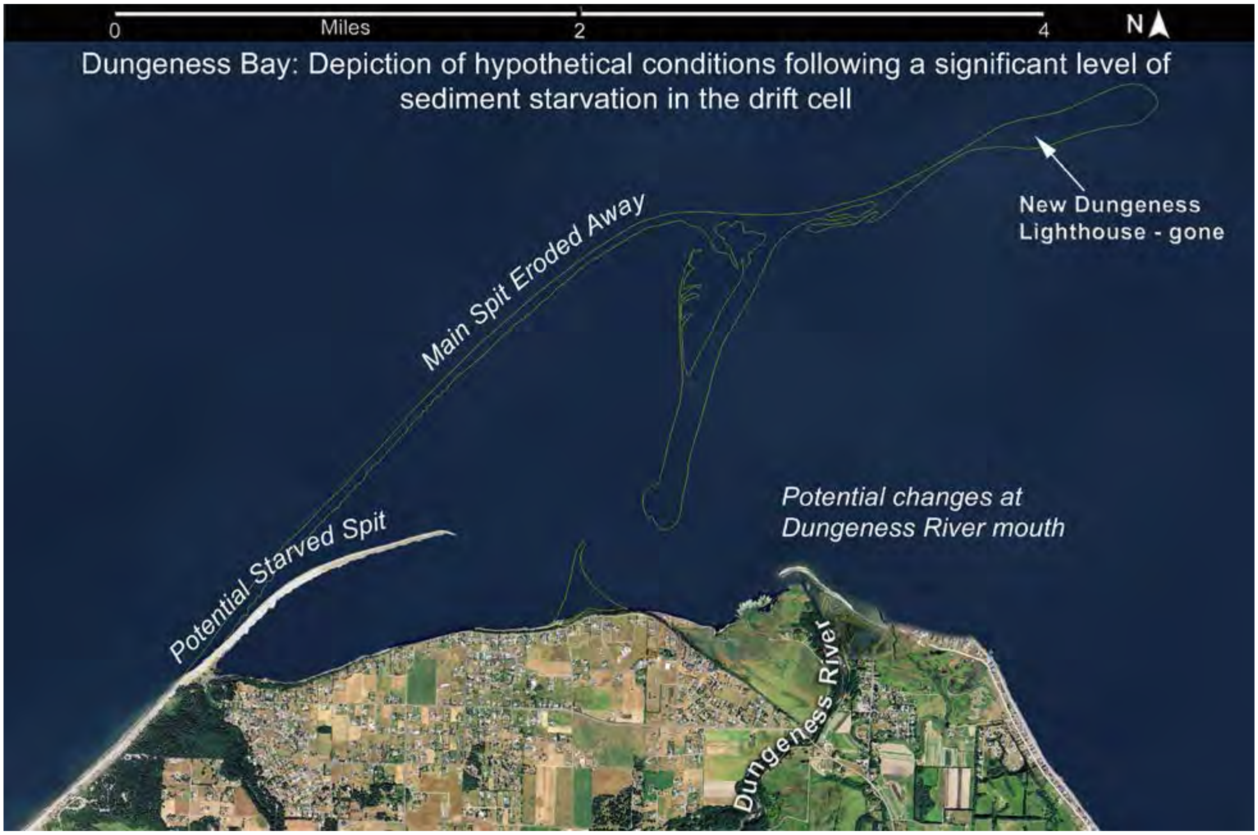


Figure 3: Hypothetical conditions at Dungeness Bay following significant sediment starvation in the drift cell. Imagery NAIP 2013.

As the shoreline west of Dungeness Spit has rapidly developed during the last several decades, the Jamestown S'Klallam Tribe has grown increasingly concerned that neither Federal, State nor the County land use regulations will prove sufficient to preserve the natural processes that created and maintain the Spit. The Tribe concluded that in order to protect this invaluable resource, it would be necessary to better understand Dungeness Spit's sediment source—the feeder bluffs—and how natural bluff erosion will likely affect the infrastructure – roads and buildings – that are closest to the bluffs. This was the genesis of the Dungeness Spit Drift Cell Feeder Bluff Recession Study. The goals of the study were the following:

- To estimate the rate of erosion (recession) of the bluffs that feed sediment to the Dungeness Spit.
- To assess the development close to the bluff.
- To inform long-range planning to protect the Spit and the life and property that depend on it.

Shoreline Processes

Shorelines formed by the deposition of sediment, such as sandy beaches and spits, are called *accretion shoreforms*. They are created by the action of wind, waves, and currents depositing (accreting) sediment in sufficient quantity to overcome the erosional forces working on the shoreline. When sufficient material is moved in one direction by longshore drift, and other conditions are right, an accretion shoreform will develop. Accretion shoreforms include wide, sandy beaches, barrier beaches, spits, tombolos (spit-like features connecting an island to the mainland), and cuspate forelands (triangle-

Figure 4: Shoreforms.

shaped spits. All accretion shoreforms require a continuous supply of new material to replace materials that are washed away. Depending on the supply of sediment, an accretion shoreform may expand (get wider, longer, or higher), remain the same size and shape, or become smaller. If the sediment supply is insufficient for a period of years or decades, the shoreform will erode significantly and might eventually disappear.

The materials that make up accretion shoreforms - sand, gravel, and cobbles - come from two main sources: streams and bluffs. Streams carry sediment produced in their watersheds and deliver this material to a lake or sea. Shorelines, when eroded, often deliver significant amounts of sediment onto the beach. Both processes provide sediment sources for accretion shoreforms. Puget Sound has a large amount of the type of shoreline called “bluffs.” Bluffs along shorelines are often high and steep and are composed of materials that range from very hard and slow to erode, to loose and easily erodible. Bluffs that contribute significant amounts of sediment to accretion shoreforms are classified as *feeder bluffs* because as they erode they “feed” sediment to the shoreform.

Feeder bluffs erode, or recede landward, at rates often ranging from 0.25 to 3 feet per year. As it erodes, a bluff's slope may change. How steep the bluff face can become before the crest erodes depends largely on the composition of the bluff. Highly unstable materials tend to form low-angle slopes; in this case, the crest erodes at almost the same rate as the toe. At the other extreme, bedrock bluffs can support sea-caves and undercut slopes. The bluffs west of Dungeness Spit are somewhere in between these extremes. At some point, the slope becomes too steep for the bluff material to support itself, and the crest erodes. When caused by wind (saltation) and small slides on the bluff face, erosion can be fairly uniform from year to year. Occasionally large slides called *mass wasting events* occur and immediately deposit large amounts of bluff material onto the beach. These episodes can produce, in a single event, sediment quantities equal to several years of average annual erosion. Wind, precipitation, and wave action remove material from the face and toe of bluffs (Figure 3). Waves, especially during storms and high tides, work along the base or toe of the bluff and spread loose material over the beach, usually within days or weeks. Wind, waves, and tidal currents transport the sands and gravels along the beach. During any given storm event or moment in time, beach material may move in any direction. Over time however, the prevailing winds and waves will move material along the beach in a particular direction. This net movement of material is called *longshore transport* (net drift or littoral drift).***Insert photos of saltation, small slides and mass wasting***

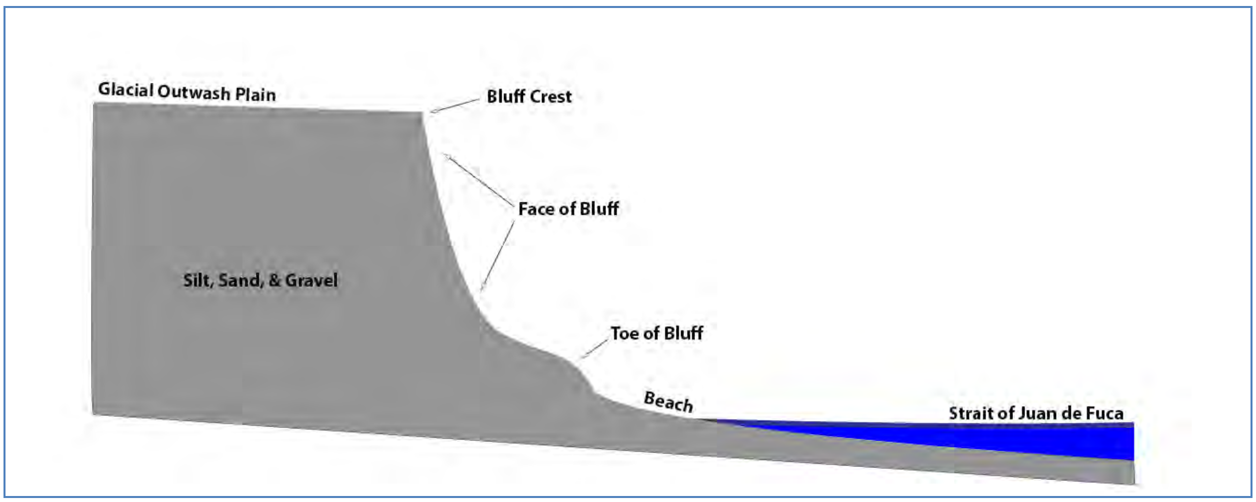


Figure 5: Simplified cross-section of a feeder bluff. Note: Natural feeder bluffs contain complexity not shown, including, but not limited to, slumps, benches, berms, and vegetation. For a more detailed beach cross section, see Figure 1 in Johannessen and MacLennan (2007).

A geologic unit composed of sediment sources – streams and/or feeder bluffs - and an accretion shoreform is called a *drift cell*. The bluffs west of Dungeness Spit are highly erodible, thick glacial deposits and they feed enormous quantities of sediment to Dungeness Spit. Thus, the Dungeness Spit Drift Cell consists of:

- the 10.5 mile bluff system extending east from the mouth of Lees Creek to the base of Dungeness Spit,

- a number of streams including Lees, Morse, Bagley, Siebert and McDonald Creeks and the Dungeness River, and
- Dungeness Spit itself.

The entire drift cell is 15.5 miles long (see Figure X). Because the bluff between Lees Creek and Morse Creek has been bulk-headed since 1915, and therefore has not contributed significant amounts of sediment to the beach in nearly a century, it is not included in the study. The streams are not included either, because they produce much less beach-sized sediment than the feeder bluffs and their sediment supply is not currently considered at-risk in any way. Hence, this study focuses on the 8.5 mile portion of feeder bluff complex extending east from the mouth of Morse Creek (Drift Cell Mile 13.5) to the base of Dungeness Spit (DCM 5).

Figure 6: Dungeness Spit Drift Cell with Drift Cell Miles (DCM's). Imagery NAIP 2013.

Although Dungeness Spit has been lengthening during the past century, it remains relatively narrow, low and fragile. During winter storms waves occasionally wash over the Spit, causing temporary gaps or breaches. Over several weeks or months the breach is repaired as longshore drift replaces the material that was washed away. However, if the amount of sediment delivered to the Spit decreases, breaches will become more common or even permanent. Over time, a reduced sediment supply would lead to a sediment-starved drift cell; the Spit could erode away, and Dungeness Bay would cease to exist. Without the protection of the Spit, the beaches and intertidal areas of Dungeness Bay would soon be scoured by large waves and tidal currents and be converted to deep water, as can be seen along other unprotected Strait of Juan de Fuca shorelines.

The sudden, large-scale erosion of nearby Ediz Hook following human impacts to its sediment supply (Appendix A), indicates the degree to which Dungeness Spit is vulnerable to sediment loss. Unlike Ediz Hook, which historically received approximately a third of its sediment supply from the Elwha River, Dungeness Spit receives only a very small portion of its sediment from the streams to the west—McDonald, Siebert, and Morse Creeks. Thus, the continued existence of Dungeness Spit, which protects critical wildlife and fish habitat, recreational resources, and human infrastructure (roads and houses), is dependent on both the natural erosion of an 8.5-mile stretch of feeder bluffs and uninterrupted longshore drift to deliver sediment to the Spit.

Erosion of a bluff face, which is often measured at the bluff crest, is called bluff retreat or *bluff recession*. Bluff recession is a natural process essential to the maintenance of diverse healthy shorelines of the Puget Sound. However, infrastructure placed near erodible bluffs can result in eventual loss of life and property, especially during rapid (episodic) bluff recession. People tend to build close to bluff crests because of the spectacular views, but doing so puts them and their infrastructure in the path of bluff recession.

The Dungeness Spit Drift Cell Complex contains feeder bluffs that are receding at various rates. The remainder of this report will focus on characterizing bluff recession in the drift cell, estimating recession rates, and assessing the infrastructure along the bluff crest. The goal is to better understand the characteristics of feeder bluff erosion and to inform a long-range planning process for protecting life, property, and the sediment source for the Dungeness Spit.

Study Area

The Dungeness Spit Feeder Bluff Complex (the study area) stretches for 10.5 miles west from the base of the Dungeness Spit to the mouth of Lees Creek. In order to facilitate bluff recession estimates, the bluff

Figure7: Feeder Bluff Complex and analysis units (imagery source 2011 NAIP).

complex was systematically, but asymmetrically, subdivided into seven units, labeled 1 through 7 from east to west. The units range in length from 0.35 miles to 2.04 miles. Expert judgment was used to determine the starting and ending points for the units (see Figure 4).

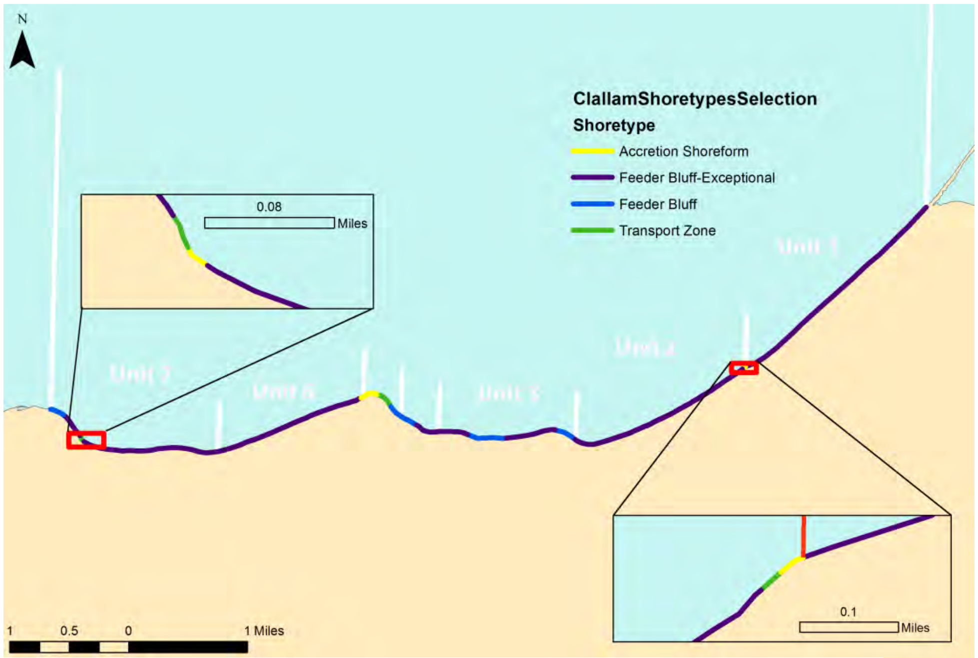


Figure 8: WA DNR Shoretype for study area.

The Dungeness Spit feeder bluffs are not uniform, but vary in numerous ways, including composition, height, average slope, amount of vegetation, aspect, and the shape of the bluff. One classification of shore structure is *shoretype*. Coastal Geological Services mapped the shoretypes for much of Puget Sound, including the study area (CGS 2012). Figure 5 depicts the shoretypes and units for the study area. Table 1 provides the approximate length and percentage of each shoretype within the complex. Feeder Bluff Exceptional is the dominant shoreform in the study area, accounting for almost 85%, while Accretion Shoreform and Transport Zone make up just over 5%. The Feeder Bluff Exceptional shoretype represents the most rapidly eroding bluffs (Johannessen and Chase 2006). As with all classification schemes, the classes impose simplicity that obscures the truly complex makeup of these natural shorelines. There is variability within all of the shoretypes (not all feeder bluffs are the same height, made of the same material, etc.). This is especially the case where there is a transition from one shoretype to another (for example, from feeder bluff to transport zone). Appendix B expands upon the analysis of the shoretypes in the study area

Table 1: Shoretypes statistics for study area

Shoretype	Miles	Percent
Accretion Shoreform (AS)	0.19	2.24%
Feeder Bluff (FB)	0.88	10.38%
FB-Exceptional (FBE)	7.17	84.54%
Transport Zone (TZ)	0.24	2.84%
Total	8.48	100.00%

Methods

The first step in this multiphase project was to estimate the recession rates of the feeder bluffs that supply sediment to the Dungeness Spit. There are currently several efforts underway to estimate the amount and volume of bluff erosion, and to estimate short-term recession rates; however, these studies will need to be repeated over a longer time frame to provide additional insight into the long-term recession rates. To precisely know the amount and long-term rates of bluff recession would require hundreds of careful measurements between surveyed control points and the bluff crest, collected over decades (preferably centuries). In the absence of accurate long-term measurements, there are a number of methods that have been used to approximate long-term bluff recession rates (NRC 1999). The method used in this study involves making distance measurements between the bluff crest and fixed reference locations on georeferenced aerial photographs (NRC 1999). For the purposes of this document, the term "reference location" is used instead of "control points," to highlight the fact that the reference locations are not surveyed locations, just highly visible points on aerial photographs. Comparing the distance between bluff crest and reference locations using a time-series of aerial photographs makes it possible to estimate bluff recession rates (distance bluff crest recessed divided by time interval between photographs).

Georeferenced aerial photosets

The Jamestown S'Klallam Tribe acquired aerial photographs for the years 1956, 1976, 1997, 2008, and 2010 for the shoreline between Morse Creek and the base of Dungeness Spit. In this document, each group of photos for a given year will be referred to as a "photoset." For example, the 1976 photoset was taken on the 8th of August, 1976. (Appendix C contains additional detail about photosets.) Individual 1956 and 1997 photographs were scanned using an Epson Expression 10000XL large-format professional grade graphic arts quality scanner. The other photosets were purchased as high-resolution electronic files from their photographic providers: the Washington Department of Transportation for the 1976 set and Bergman Photographic Services for the 2008 and 2010 sets. All photos were precisely georeferenced and brought into a Geographic Information System (GIS). The 2010 photoset was georeferenced against the National Agriculture Imagery Program (NAIP) 2009 orthographic aerial imagery (NAIP 2009). Because the NAIP imagery is lower resolution than the 2010 photoset, the 2010 photoset was used as a master and all other photosets were georeferenced to the 2010 photos.

Once all of the photos were georeferenced, each photoset was inspected to find suitable reference locations. Ideally, reference locations are clearly visible in at least one photo in all photosets, represent an object that can't be easily moved, and are relatively near a section of bluff crest that is not obscured by vegetation, shadows, or photographic imperfection. Because air photos always distort ground-based features to some extent, reference locations close to the center of photographs and physically located closer to the ground were considered the best candidates, where they were available. The corners of structures, roads, driveways, and single trees make good reference points if they are clearly visible in most or all photosets. The early photos (1956, 1976) contain fewer structures and associated infrastructure than the more recent photos, while some structures visible in the early photos have been moved or torn down. All these constraints resulted in a limited set of reference locations.

> Note about photo selection: The photos in a photoset often overlap significantly, so a single reference point may be visible in two or more photos in the same photoset. In this case, the photo with the clearest and least distorted view of the reference point and bluff crest was selected to be used for the measurements. As mentioned above, there is often less distortion in the center of each photo; however, the number and location of available georeferencing control points (control points in this context differ from surveyed field locations and monuments) used during the photo georeferencing play a role in overall photo distortion. The analysis used expert opinion to weigh all of these factors when determining the best available photo to use for each measurement. Because the bluff-top areas along the feeder bluff complex are relatively flat, the distortion of ground features within the images is minimized but not eliminated. A detailed description of the georeferencing process is beyond the scope of this document; however, a number of books and publications are available on the topic.

The distance from a reference location to the bluff crest (roughly perpendicular to the bluff crest) is the key measure used in estimating rate and amount of bluff recession. Reference locations are at a premium in the study area and are not evenly spaced along the drift cell; thus, analysis units and subunits contain different quantity and quality of reference locations. This is a source of unmeasured variance in the estimates.

For each photoset a measurement between the reference location and the bluff crest was made on the most suitable photo. If the reference point and the bluff crest were clearly visible in each selected photo in each photoset, then five measurements would be made (1956, 1976, 1997, 2008, and 2010) at each reference location. It should be noted that the georeferenced photosets do not match precisely between years at each reference location because of variations in camera type, flight-platform elevation, location, pitch, yaw, and roll as well as variations in the georeferencing. To reduce the error associated with these differences, each measurement was made on only one image, where possible. Shading, sun angle, riparian vegetation, and changes in land cover and land use result in reference points and bluff crests not always visible in every photoset. These variations made some measurements more difficult or impossible. At sites and dates where the bluff crest was clearly visible but the reference location was not visible, distance from bluff crest to reference location was estimated using a reference line. Reference lines were created using the following methodology:

- Using the 2010 georeferenced photoset, the sixty-four reference locations were marked to produce a reference point GIS dataset. Note: Due to the previously mentioned differences between photos, the reference point may not fall exactly on the reference location when viewed on photos other than the photo used to create the points.
- Each reference point was used in the GIS to create a single reference line (GIS line dataset) parallel to the bluff crest and intersecting the reference point. The reference line was extended some distance in either direction away from the reference point.
- Viewing the reference line features in the GIS over the selected photo (where the reference location is missing), a distance was measured between the bluff crest and the reference line perpendicular to the reference line. In this case the reference line is a proxy for the reference location. While these measurements may be quite accurate, not

having a visible reference location creates a greater level of uncertainty and adds variance due to photo-to-photo georeferencing differences.

Quality Control

Measuring each of the 64 reference locations on all 5 photosets would result in 320 individual distance measurements across the drift complex. However, several factors reduced the number of actual usable values. In 24 instances a distance measurement was not made because of difficulties in determining the precise location of the bluff crest in a photoset, resulting in 296 individual distance measurements. After careful consideration of the quality of the data, distance values were used to estimate bluff recession only where both the reference location and the bluff crest were clearly visible. Photosets were georeferenced to a high degree of accuracy where possible. Some individual photos proved to be challenging to georeference because of a lack of suitable ground control points or the control points not being spread spatially across the photo. Expert judgment was also used to eliminate any distance values that were generated using photos where the quality of the georeferencing may have resulted in excess photo distortion. Following all quality control efforts, the final tally of distance locations that met the above criteria was 226.

The individual distance measurements alone are not significant; it is the change in distance over time (subtracting an older distance value from a more recent value at the same location) that provides an estimate of bluff recession (see Figure 6). Using all 5 photosets provides 10 possible time intervals. Comparing only the highest quality distance measurements for the 10 time intervals resulted in 314 individual bluff recession estimates across the bluff complex.

This report emphasizes the bluff recession averages for the longest time intervals where sufficient results were available and where the maximum annual rates of bluff recession were found. In general, the shorter the time interval between photosets, the greater likelihood of qualifying the effects of a larger episodic rapid recession event. Therefore, most of the maximum recession rates were found using the 2008 to 2010 photosets. The 1956 to 2010 time interval is the longest available; however, only 12 recession values met the quality control criteria, so these data are used only for recession estimates for the entire study area. The 1976 to 2010 interval was determined to provide the best available long-term bluff recession averages for individual units.

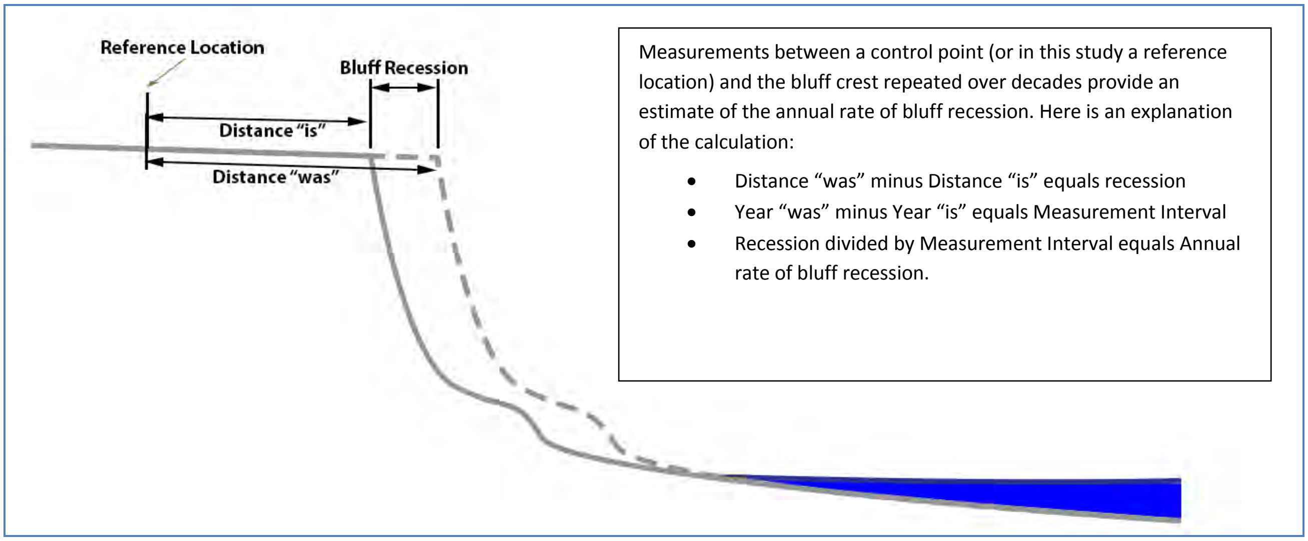


Figure 9: Explanation of bluff-recession-to-reference-location measurement.

> Note: The following is a simplified hypothetical example calculation to further illustrate the method used in this study. Assume the distance from a given reference location to the nearest point along the bluff crest was 100 feet (distance "was") in 1956 (year "was") and 50 feet (distance "is") in 1976 (year "is"); then the change in distance was 50 feet in 20 years. Dividing the change in distance (50 feet) by the measurement interval (20 years) yields 2.5 feet per year as the average annual recession rate. If a home was built in this area with a 100-foot setback from the bluff crest in 1976 and the average annual recession rate was accurate, then sometime before 2016 the home would need to be repositioned farther back from the bluff or else be removed.

Comments on precision and accuracy

While all of the methods used in this study were performed with care and the results were checked by a second analyst, the method did not include any replication of individual measurements. Acquiring, scanning, and georeferencing the aerial imagery is tedious, time consuming, and expensive. Finding an additional high quality photoset taken in the same timeframe to use to create replicate measures is unlikely, especially for the older time periods. Given these constraints, this study does not include estimates of either the precision or accuracy of individual distance measurements or of the bluff recession rates derived from the distance measures. There is however, replication across the drift cell and across most of the units. Please note the "N" (number of replicates) associated with each estimate in the tables and figures below. The results below are very suitable for long-term planning purposes.

Discussion and Results

The study results are grouped into bluff recession estimates for the entire feeder bluff complex and recession results for each analysis unit, and then followed up with analysis comparing the distance between the bluff crest and some existing structures. Where available, both long-term average rates of bluff recession and maximum rates are presented. Long-term average rates are important for some long-range planning processes, because the averages provide an estimate of recession rates over an extended time period. However, this does not tell the entire story. The maximum rate at a given location or area is also an important value, because it provides some indication of how fast bluff recession can take place over the short term.

NOTE: AVERAGES VS MAXIMUMS. Where bluff recession rates are characterized as "average", these rates are the average of all the individual estimated recession rates measured within a unit or within the entire study area. Recession rates characterized as "maximum" are represented by a single site within each unit or within the entire study area. In each unit, only one measurement site represents the "maximum" rate, while the "average rate" includes the estimates from all the measurement sites.

Entire Feeder Bluff Complex, 1956 to 2010.

For the period 1956 to 2010 we estimated recession rates at a total of 12 individual sites within the entire feeder bluff complex. When combining all these estimates, the average rate of bluff recession was 0.97 feet per year. For this time period, the lowest recession rate measured at any site was 0.06 feet per year, while the highest rate measured at any site was 1.56 feet per year.

Entire Feeder Bluff Complex, 1976 to 2010.

For the period 1976 to 2010 we estimated recession rates at a total of 37 Individual sites within the entire feeder bluff complex. When combining all these estimates, the average rate of bluff recession was 1.00 feet per year. For this time period, the lowest recession rate measured at any site was 0.15 feet per year, while the highest rate measured at any site was 3.28 feet per year.

Maximum Rates.

Because much of the bluff recession along the drift cell complex is believed to occur episodically, especially during periods of high tides, high wave energy, and/or high rainfall events, a longer time interval of analysis tends to produce lower maximum recession rate estimates. For example, the most recent and shortest time interval was between the 2008 photoset (5/16/2008) and the 2010 photoset (3/6/2010), a period of 659 days or 1.81 years. This interval captures a publicized period of rapid bluff recession in Unit 2 near the Monterra community. According to reports (PDN 2010), over a 3-hour period on February 1, 2010, a 150-foot length of bluff receded 40 feet. This reported amount of recession appears to be exaggerated. Our study included several reference points near this area of rapid recession and one of these reference points provided the maximum recession rate (26.41 feet lost divided by 1.81 year = 14.59 ft /yr) for the study area. Given the reported rapid recession, it is possible that the bulk of the 26.41 feet was lost in this one event. It would be impractical to collect and analyze daily or even monthly aerial imagery; therefore, precise episodic recession rates are beyond the capability of this type of study. Over the last few years, the Tribe has collected imagery every year or two in order to make it easier to document the fluctuation in annual rates in the future. However, unless more high resolution historical aerial imagery becomes available for the study area, it will be difficult to get a clearer picture of the historical fluctuations in recession rates.

When compared to extreme episodic rates (possibly 26 ft. /day), the maximum rate measured for the period 1956 to 2010 is only 1.56 feet per year, although this is based on only 12 measurements along 8.5 miles of bluff. At the other end of the range, one area lost only 3 feet over the entire 54-year study period (this is approximately 0.66 inches per year). These maximum and minimum rates clearly show that recession rates vary across time and across the feeder bluff complex. For current and prospective owners of valuable infrastructure located near this bluff complex, the average erosion rate of approximately 1 foot per year may be less important than the rare, unpredictable, but large erosion event where tens of feet might be lost in a single day.

Temporal changes in bluff recession rates.

There is at least qualitative evidence that bluff recession rates are slowing over the study period. The average rate of bluff recession found between 1956 and 1976 was 1.21 feet per year (N=12), while average during the period 1976 to 1997 was estimated at 1.00 feet per year (N=36) and the notably shorter period 1997 to 2010 was estimated at 0.88 feet per year (N=52). The reason for this decrease in recession rates is unknown; it could be due to land use changes, or it might simply be an artifact of the measuring methodology. There are an increasing number of high quality reference locations and shorter time periods in the more recent photosets.

While no modeling of future bluff recession has been undertaken, some models predict more frequent and more severe storms in the study area because of global climate change. This combined with the predicted rise in relative sea level along the feeder bluff complex may result in an increase in bluff recession rates and greater frequency of large mass wasting events. These larger erosional events would likely be necessary to supply the increased sediment required to maintain Dungeness Spit during sea level rise. Although accurately predicting an increase in future bluff recession rates is not currently possible, recession will certainly continue and remain highly variable, both across the drift cell and over time.

Drift Unit Recession Rates

Bluff recession rates averaged across the entire complex obscure the variability of these rates at any given location. To better understand the spatial variability, the feeder bluff complex is divided into 7 smaller analysis units. During the period 1976 to 2010, Unit 2 (McDonald Creek to Monterra) had the highest average recession rate (2.03 ft/yr) and maximum recession rate (3.28 ft/yr). The maximum value across all the time intervals (14.59 ft/yr also occurred in Unit 2 during the period 2008 to 2010. The lowest 1976 to 2010 rate was 0.15 ft/yr at Green Point, the sole measurement site in Unit 5. Since Unit 5 has only one reference location, no average or maximum is provided. Figure 7 shows all average and maximum values for each analysis unit for the time period 1976 to 2010.

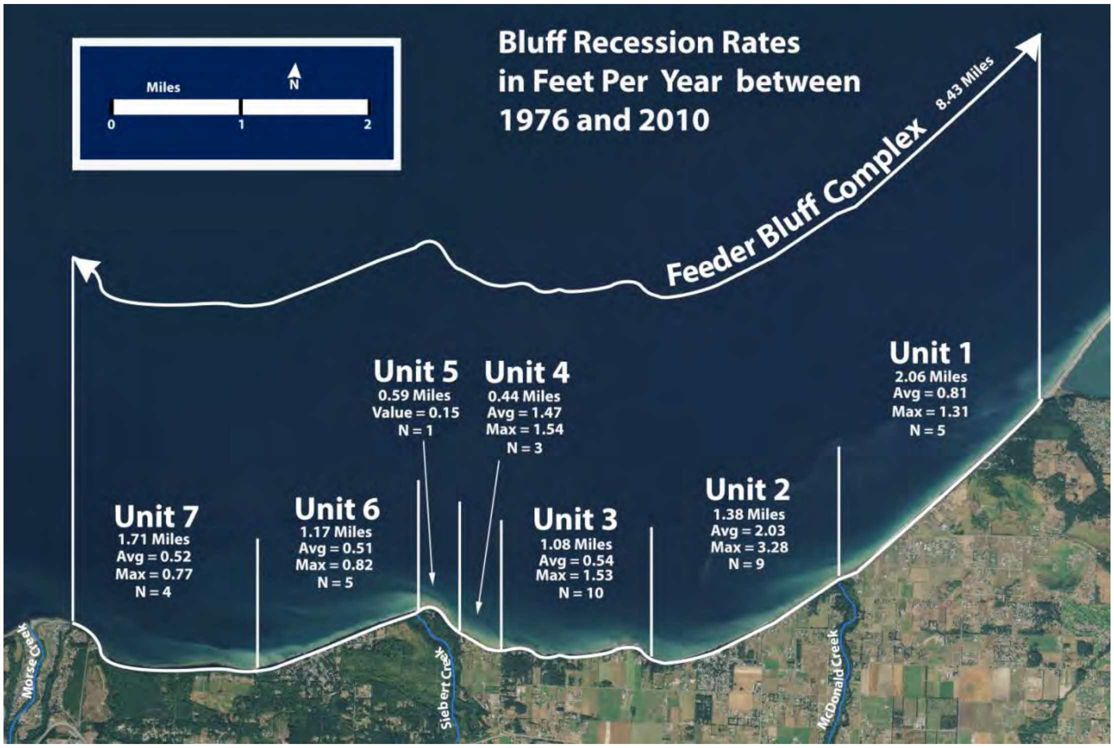


Figure 10: Bluff recession averages and maximum values for each analysis unit. Avg = the average annual rate of bluff recession for all the reference locations within the Unit. Max = the annual rate of bluff recession at the reference location with the highest rate of bluff recession within the Unit. N = the number of reference sites within the Unit. See Appendix D for discussion of shoreline length estimates.

Unit	Location	Length (miles)	Avg. Recession Rate of all reference locations in Unit (feet per year)	Recession Rate at reference location with highest recession rate within Unit (feet per year)	No. of Ref Sites	Time Period of Measurements
1	Dungeness Spit to Mariner's Point (DCM 5.1 to 7.2)	2.06	0.81	1.31	5	1976 to 2010
2	Osborn Road (McDonald Creek) to Monterra(DCM 7.2 to 8.6)	1.38	2.03	3.28	9	1976 to 2010
3	Calbert Road to Finn Hall Road (DCM 8.6 to 9.7)	1.08	0.54	1.53	10	1976 to 2010
4	Wildflower Lane to Gerkhe Road (DCM 9.7 to 10.2)	0.44	1.47	1.54	3	1976 to 2010
5	Green Point (DCM 10.2 to	0.59	0.15	0.15	1	1976 to 2010

	10.8)					
6	The Bluffs and west (DCM 10.8 to 12.0)	1.17	0.51	0.82	5	1976 to 2010
7	Gasman Road to Buchanan Drive (DCM 12.0 to 13.7)	1.71	0.52	0.77	4	1976 to 2010
All	Dungeness Spit to Buchanan Drive (DCM 5.1 to 13.7)	8.48	1.00	3.28	37	1976 to 2010
All	Dungeness Spit to Buchanan Drive(DCM 5.1 to 13.7)	8.48	0.97			1956 to 2010
All	Dungeness Spit to Buchanan Drive(DCM 5.1 to 13.7)	8.48	1.21		12	1956 to 1976
All	Dungeness Spit to Buchanan Drive(DCM 5.1 to 13.7)	8.48	0.88		52	1997 to 2010

Parcel Analysis

What can these bluff recession rates tell us about individual parcels and structures built along the bluff? For this part of the analysis, the bluff complex-wide, 1976-to-2010 average recession rate of 1 foot per year is compared to the distance between the 2012 bluff crest (available from high resolution elevation data) and structures built along the bluff. For this analysis, only the primary structure (home/business) was included. Structures that were clearly identifiable as barns, storage sheds, etc. were not considered "primary" structures and not included in the analysis.

Six primary structures are located within 10 feet of the bluff crest. Assuming a long-term average recession rate of 1 foot per year, in 10 years or less these 6 structures will likely be undermined. A single large erosion episode could cause any of these structures to fall off the bluff. An additional 11 primary structures are located between 10 and 25 feet of the 2012 bluff crest. With one documented erosion episode exceeding 26 feet, these 11 structures appear to have little or no safety margin.

The historical air photographs used to develop our bluff recession rates capture several examples of structures being moved back from the approaching bluff crest. Figure 8 shows one example where a structure was moved away from the bluff crest. It also provides an example of the temporal variability of bluff recession rates. In this location, between 1956 and 2010 the long-term average bluff recession rate was 1.52 feet per year; however, between 1956 and 1976 the rate was 0.74 feet per year, between 1976 and 1997 the rate was 2.51, and, finally, between 1997 and 2010 the rate was 1.17.

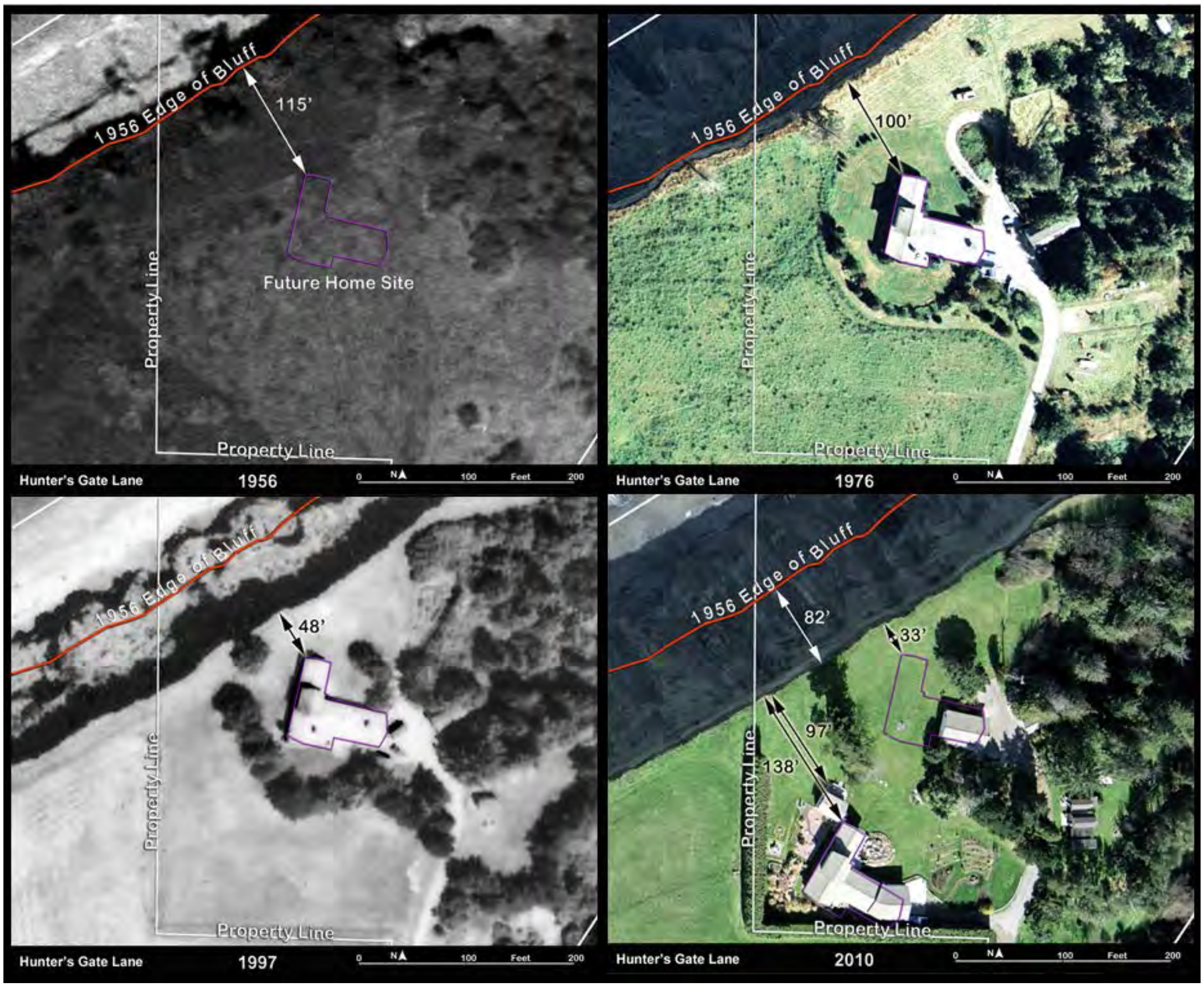


Figure 11: Bluff crest recession results in structure relocation at Hunter's Gate Lane.

Using the maximum rate of 26 feet per year as seen during the winter of 2010, any structure within 25 feet of the bluff top could be undermined in a single episode. As more is learned about bluff recession in general and the Dungeness Spit feeder bluff complex specifically, it may be possible to provide much more detailed analysis of bluff erosion and recession and the potential for structure undermining. In the interim, Clallam County's planning division uses 75 years as its long-range planning horizon. Assuming the conservative 1 foot per year recession rate, a minimum of 78 structures will become unsafe and need to be removed, moved, or watched carefully over the next 75 years.

Within Unit 1, the closest structure is 37 feet from the bluff crest. The average rate of annual recession for Unit 1 is between 0.43 foot per year and 1.31ft/year, giving this structure between 28 and 86 years before it may be undermined. The closest structures in Unit 2 are in the area of the rapid recession event of February 2010. This recent bluff recession may provide some local and temporary protection from future recession by providing additional material at the toe of the bluff (see debris fan in Figure 9). However, if the long-term average rate were to remain steady for Unit 2, many of the structures in

Figure 9 could be in danger in 10 to 20 years. Units 4, 6, and 7 have at least one structure within 5 feet of the bluff crest. These structures are likely to be in jeopardy within the next decade.

Figure 12: 2010 Aerial images showing the recent rapid recession in the Monterra area of Unit 2. Note the fan shaped debris flow. Additional images of structures close to the bluff crest are provided in Appendix E.

As a further long-term planning exercise, estimates of the number of existing structures that may need to be moved in 150 years or 300 years are provided. To simplify the analysis, a 1 foot per year recession rate is used again. Within the next 150 years, a total of 129 primary structures must be moved and within 300 years 154 structures would need to be moved.

Conclusions

Dungeness Spit and its magnificent resources can persist only as long as the Spit's sediment supply remains uninterrupted. Conserving this sediment supply requires that the natural processes of bluff erosion and longshore drift be allowed to continue without human interference. Our calculated bluff recession rates, ranging from 0.06 to 14.59 feet per year, provide baseline information for predicting the time when existing structures will become unsafe. More importantly, these rates also provide a basis for planning sustainable, prudent development that protects human investments and safety—on the bluffs and the developed shoreline east of the Spit—while conserving irreplaceable natural resources at

Dungeness Spit and Dungeness Bay. Although the effects of climate change and sea level rise cannot be accurately predicted at this time, they will probably increase the rate of bluff recession, possibly by a significant amount.

Private property owners, local, state, and federal governments and affected Indian tribes should collaborate to develop measures for protecting life and property along the bluffs of the Dungeness Spit Drift Cell, while conserving Dungeness Spit's essential sediment supply. Recommended measures include:

- Provide incentives to conserve natural bluff habitats and to keep or move structures away from the bluff crest.
- Purchase and removing at-risk structures.
- Purchase bluff conservation easements.
- Establish adequate regulatory setbacks and buffers for all new development. We recommend a minimum buffer of 150 feet from the bluff crest. This distance should be increased if bluff recession rates are observed to increase, either from sea level rise or more frequent extreme weather events.
- Establish regulatory prohibitions against shoreline armoring and the construction of structures that would interrupt or halt longshore sediment transport within the Dungeness Spit Drift Cell.

These are some of the measures we view as necessary to protect the multitude of human and natural resource values that depend on the continued existence of the Dungeness Spit and the natural processes that maintain it.

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Appendix A: Ediz Hook—A Cautionary Tale

Ediz Hook, a sand and gravel spit that created the bay and harbor of the City of Port Angeles, was 3.4 miles long when first described by European-American settlers in the 19th century. Sediment coming from the Elwha River and erosion of feeder bluffs located between the Elwha River mouth and the Hook created and maintained the spit until the early 20th century. Then human impacts began to reduce Ediz Hook's sediment supply. First, the construction of two dams on the Elwha River blocked sand and gravel moving down from the Olympic Mountains. Soon thereafter, in 1930, a major bulkhead—2,400-feet long—was constructed near the base of the feeder bluffs to protect a stretch of the Port Angeles industrial waterline that had been buried along the shoreline. The waterline bulkhead caused bluff erosion to decline dramatically, from 3.6 feet per year to less than one foot per year. With the reduction in the supply of river and bluff sediment, the Ediz Hook began to "starve" —to erode away in the storms and winds without sufficient sediment to replenish it. Only seven years after the feeder bluffs were armored, the City of Port Angeles, in fear of losing the harbor, built its first major shore defense project on Ediz Hook—7,000 feet of log-crib bulkhead.

In 1945, work to save the Hook entered a phase of furious activity, with projects by the Coast Guard (1,350 feet of riprap bulkhead and 6 timber groins built in 1945-46), Crown Zellerbach Corporation (1,900 feet of pile, timber and riprap bulkhead in 1946-47 and 1,800 feet of riprap bulkhead in 1949), and the City, Coast Guard, and various industries (4,000 feet of timber and riprap bulkhead in 1951). Only 21 years after the construction of bulkheads along a portion of the Hook's feeder bluffs, it had become necessary to armor virtually the Hook's entire outer shoreline to prevent it from eroding away.

Despite this monumental amount of shoreline armoring, Ediz Hook continued to erode seaward of the bulkheads, causing bulkhead failure and the need for incessant maintenance of the shoreline defense works. By 1961 the entire outer shoreline of Ediz Hook had been riprapped and was being maintained annually. This maintenance is now performed by the U.S. Army Corps of Engineers, at an estimated cost of $500,000 to $1,000,000 for 2011 alone. The Ediz Hook case history clearly illustrates the swift, catastrophic consequences of armoring feeder bluffs that support important shoreline features.

Appendix B: Description of the Analysis Reaches (Units).

In order to facilitate bluff recession estimates, the bluff complex was systematically, but asymmetrically, subdivided into seven units (labeled 1 through 7 from east to west). The units range in length from 0.35 miles to 2.04 miles. Expert judgment was used to determine the starting and ending points for the units (see Table A-1).

Table A-1: length of each analysis unit is miles and percent of total bluff complex length (8.48 miles)

Unit	Miles	Pct. of Complex
1	2.04	24.07%
2	1.61	18.97%
3	1.20	14.16%
4	0.35	4.17%
5	0.40	4.77%
6	1.31	15.48%
7	1.56	18.37%
Total	8.48	100%

Coastal Geological Services (CGS) delineated the shoretype of the marine shoreline of the county. Shoretype is a categorical representation of the geological shoreform. CGS has used the same process for much of the shoreline of Puget Sound. The shoretype categories are shown in Table A-2.

Table A-2: Shoretype code and descriptions (note: study area includes only Feeder Bluff, Feeder Bluff Exceptional, and small amounts of Transport Zone and Accretion Shoreform.

Shoretype Code	Shoretype Description
FBE	Feeder Bluff Exceptional
FB	Feeder Bluff
FB-TS	Feeder Bluff Talus
TZ	Transport Zone
AS	Accretion Shoreform
MOD	Modified
NAD	No Appreciable Drift

The Dungeness Spit Drift Cell Complex includes only Feeder Bluff, Feeder Bluff Exceptional, Transport Zone, and Accretion Shoreform. Unit 1 is entirely the shoreform Feeder Bluff Exceptional, while all the other Units are a mix of shoretypes. Only Unit 5 does not have Feeder Bluff Exceptional. The lengths of each shoretype in each unit and the percentages are shown in Table A-3.

Table A-3: Analysis of the shoretype for each unit. Includes Unit number, Shoretype, miles of each shoretype in the unit, and the percentage of the length of the unit shoreline composed of each shoretype.

Unit	Shoretype	Miles	Percent of Unit
1	Feeder Bluff Exceptional	2.04	100.00%
2	Accretion Shoreform	0.02	1.05%
	Feeder Bluff Exceptional	1.58	97.94%
	Transport Zone	0.02	1.01%
3	Feeder Bluff	0.49	40.69%
	Feeder Bluff Exceptional	0.71	59.31%
4	Feeder Bluff	0.16	44.46%
	Feeder Bluff Exceptional	0.20	55.54%
5	Accretion Shoreform	0.12	30.21%
	Feeder Bluff	0.12	28.85%
	Transport Zone	0.17	40.95%
6	Accretion Shoreform	0.02	1.78%
	Feeder Bluff Exceptional	1.27	96.47%
	Transport Zone	0.02	1.75%
7	Accretion Shoreform	0.03	1.77%
	Feeder Bluff	0.12	7.56%
	Feeder Bluff Exceptional	1.38	88.36%
	Transport Zone	0.04	2.32%

Appendix C: Photosets.

The Jamestown S'Klallam Tribe's Natural Resources Department acquired six sets of photographic prints taken by various organizations between May 1956 and March 2010. Each photograph was scanned into high quality digital format and carefully georeferenced in a geographic information system. The source and method of acquisition varied (Table B-1).

Table B-1: Photoset source information.

Photoset	Source	Acquisition Method	Date taken
1956	Clallam Co. Assessor	Loan	5/16/1956
1976	WSDOT	Purchase	9/8/1976
1997a	WDNR	Purchase	5/16/1997
1997b	WDNR	Purchase	8/5/1997
2008	Bergman/JSKT	Purchase	5/16/2008
2010	Bergman/JSKT	Purchase	3/6/2010

		Interval Days (recent date minus old date)					
Photoset	Date taken	1956	1976	1997a	1997b	2008	2010
1956	5/16/1956	0	7420	14975	15056	18993	19652
1976	9/8/1976		0	7555	7636	11573	12232
1997a	5/16/1997			0	81	4018	4677
1997b	8/5/1997				0	3937	4596
2008	5/16/2008					0	659
2010	3/6/2010						0

		Interval Years (Interval days/365)					
Photoset	Date taken	1956	1976	1997a	1997b	2008	2010
1956	5/16/1956	0	20.33	41.03	41.25	52.04	53.84
1976	9/8/1976		0	20.70	20.92	31.71	33.51
1997a	5/16/1997			0	0.22	11.01	12.81
1997b	8/5/1997				0	10.79	12.59
2008	5/16/2008					0	1.81
2010	3/6/2010						0

Not used for comparisons.

Photoset	Area
1997a	Dungeness Spit to McDonald Cr E2 and The Bluffs to Morse Creek
1997b	VOA (McDonald Cr. E1) to Green Point (Green Point 2)

Table B-2: Number of days and years between photosets

Photosets were each flown/taken in a single day; however, the day of the year varied (Figure B-1). Three of the photosets were taken on May 16 of the respective year, while the 2010 photoset was taken in early March and the 1976 and 1997b photosets were taken in late summer. When calculating annual bluff recession, the differences in the time of year the photoset was taken were accounted for by calculating the number of days between photosets (Table B-2). The number of days between photosets divided by 365 provides the fractional number of years between photosets. To produce the estimates of annual bluff recession, the change in distance between the two photosets (e.g. 1976 to 2010) from the bluff crest to the reference point was divided by "Interval Years" (1976 to 2010 = 33.51 years) and if, for example, the change in distance was 51.33 feet, then 51.33ft/33.51years=1.53 feet per year. A photoset covering the entire study area was not available for the 1990s; the best available photo record was compiled using two photosets, 1997a and 1997b. Photoset 1997a was taken May 16′ while the 1997b photoset was not taken until August 5. The 1997 photosets' spatial extent covers differing parts of the complex with minimal overlap; these were not used to compare changes between spring and fall 1997.

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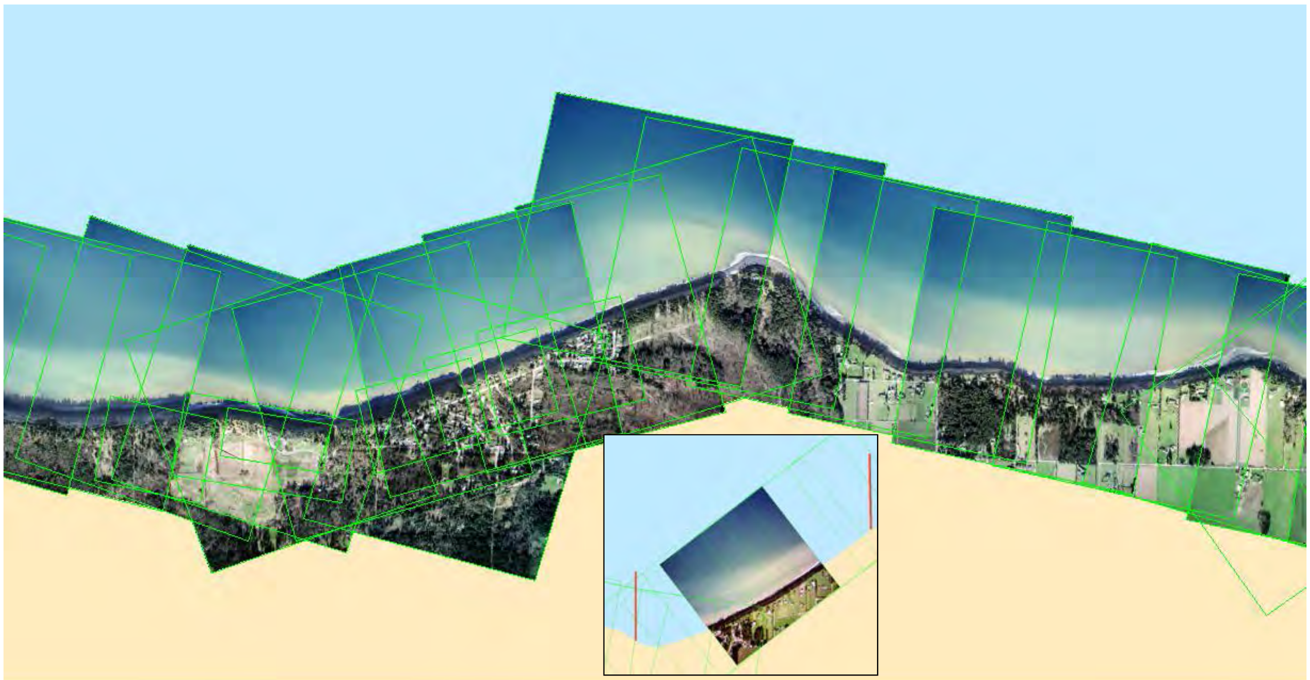

Figure B-1: Example of photoset (2010) overlap and spatial distribution. The inset shows the size of an individual image.

Appendix D: Measuring Linear Natural Features.

Natural features like shorelines and streams are often represented on maps as line features. The advent of computerized GIS made determining the length of these representative features trivial. However, getting an accurate measurement of the actual length of a river or shoreline in essentially impossible. Natural linear features are best represented mathematically by fractals. For both natural shorelines and fractals, the more you "zoom in," the more complexity is revealed. This phenomenon is called the "Coastline Paradox" (http://mathworld.wolfram.com/CoastlineParadox.html), which, crudely stated, is that the length of a coastline, shoreline, or river depends on the method and scale of the measurement. In this document, the lengths of shoreline segments were derived from GIS using the DNR Shorezone [szline] dataset.