Geocoastal/Geotechnical Report
Admiral’s Cove Beach Club, Inc.
Project Number 20-064

Prepared for Admiral’s Cove Beach Club, Inc.
Prepared by Coastal Geologic Services, Inc.
Contributors/Authors: Jim Johannessen LEG, MS and Avery Maverick GIT, MS

COASTAL GEOLOGIC SERVICES

February 22, 2021

Table of Contents

Table of Tables

Introduction and Purpose

At your request, Coastal Geologic Services, Inc. (CGS) has prepared this Geocoastal/Geotechnical Report which assesses coastal processes, coastal erosion trends and likely causes, seal level rise, and evaluation of whether there is a need for some type of shore protection for the community pool area and drainfield of the Admiral's Cove Beach Club. This report documents site conditions, summarizes the evaluation, and recommends a general type of shore protection.

The Admiral's Cove Beach Club is located at the intersection of Keystone Ave and S. Byrd Drive on the northwest shore of Admiralty Bay on central Whidbey Island (Figure 1). The site shore faces south-southwest onto Admiralty Inlet. The subject property is the community-owned area and consists of a section of S. Byrd Drive, a gravel parking area, a septic drainfield area, a landward lagoon and tide gate, a play area, two adjoined out shelters, and a recreational pool and associated facilities (Figure 2).

Site Conditions

Site conditions relevant to discussion of the beach area and management thereof are summarized in this section. Jim Johannessen, Licensed Engineering Geologist and MS and Avery Maverick, GIT and MS, conducted a site assessment on December 18, 2020 and meet with several community members. Areas inspected during this visit include the uplands of the property, the adjacent lagoon and tide gate, the septic drainfield, and the waterfront area.

Geology

The surficial geology of the subject property in the immediate project area was mapped as Holocene beach deposits (Qb) (Polenz et al., 2009). This is described locally as a mix of sand and cobbles; may include boulders, silt, pebbles, and clay; pebbles and larger clasts typically well rounded and oblate; mostly well sorted; loose; derived from shore bluffs and underlying deposits and/or carried in by longshore drift.

Immediately landward of the beach deposits, the surficial unit was described as Pleistocene glacial and nonglacial deposits (Qc) composed of sand, silt, clay, peat, and some fine and rare medium gravel; compact; well stratified to massive. Further landward, the surficial geology was mapped as Pleistocene continental glacial drift (Qgdm(e)). This unit is comprised of clayey to silty diamicton with variable content of gravel clasts and is interpreted to be sea-floor sediment and consists mostly of glacial flour which reflects its proximity to the ice front during the Everson Interstade. Other surficial units located to the northwest under the roadway include artificial fill (af) and Quaternary bog, marsh, and swash deposits (Qp).

The waterward portion of the property was mapped as "stable" in the Coastal Zone Atlas of Washington for Island County (WDOE, 1979). The uplands area and the lagoon were mapped as "modified" which indicated that the slopes are highly modified by human activity and include areas of significant excavation or filling.

Coastal Processes and Beach

The beach at the property is part of a long-term littoral sediment transport system known as a net shore-drift cell. A net shore-drift cell represents a natural system with sediment input from feeder bluffs (and other sources) to a beach, transport alongshore with intermittent additional sediment input, and deposition in one or a number of accretion areas in the down-drift end of the drift cell where wave energy diminishes or some barrier limits the further littoral transport (Johannessen and MacLennan, 2007). The site is within net shore-drift cell ISWH034 (Johannessen and Chase, 2005). This drift cell originates at Lake Hancock in a net-shore drift divergence zone and extends northwestward until it terminates just west of Driftwood Park (Figure 1). Net shore-drift is generally from southeast to northwest at the subject property. The beach at the property is classified as an accretion shoreform which is a term to describe depositional beaches that have developed seaward of the original coastline (Coastal Geologic Services, 2017).

This property has a maximum fetch (over-water distance that wind-driven waves are generated) of 13.7 miles from the south, making this a high-energy site in Puget Sound terms with respect to wave action. The mean higher high water (MHHW) elevation is 8.52 FT above mean lower low water (MLLW) at the site based on the nearby NOAA water level station at Port Townsend (Station #9444900, Table 1). Annual king tides typically occur in winter months and can surpass 12 FT MLLW elevation when storm surge occurs. The storm surge at the site can reach 2.0 to 2.5 FT above predicted (astronomical) tide in extreme low-pressure storm conditions.

Table 1. Tidal elevations at the project site, based on NOAA Port Townsend Station (#9444900).

Tides	FT, MLLW	FT, NAVD88
Highest Astronomical Tide (HAT)	10.0	9.10
Mean Higher High Water (MHHW)	8.52	7.61
Mean Higher High Water (MHW)	7.84	6.93
Mean Lower Low Water (MLLW)	0.0	-0.907

The shoreform is considered a barrier beach, or a narrow ridge that rises above the water roughly parallel to the shore, from which it is separated by a lagoon. Beach sediment was composed of a mix of sand to cobbles in the upper beach and at mid-beach elevation. The backshore was predominantly composed of small cobbles to pebbles. Shore armor was not present along the property, but residential properties to the northwest were armored with a variety of rock bulkheads, including rockery walls, rock revetments, and rock with mortar. Drift logs were pervasive within the subject parcel, and a few larger logs were located placed in the upper beach directly below the pool enclosure which offered a very small amount of protection.

Coastal erosion was experienced as we understand it primarily during the December 20, 2018 high water windstorm along with several other smaller events. The Admiral's Cove Beach Club is concerned about the integrity of the pool area and pool enclosure wall and patio, as well as the septic drainfield for the pool and community building area, which is located north of the pool (Figure 2).

The beach was slightly narrower southeast of the pool and enclosure as compared to the southwest corner. The level high elevation area at the same elevation as the pool area only extended 2 FT waterward of the fence here. The backshore slope dropped off waterward of the pool area and included a 15 FT wide drift log zone which ended 30 FT waterward of the pool enclosure. This log area was near level at the active berm crest, which was measured at 2.0 FT below the ground at the pool enclosure (See Photo Page). The high tide beach waterward of the logs dropped off more steeply at a 3.3:1 slope over a 17 FT horizontal distance.

Current Water Level Conditions

Local MHHW and the HAT tide elevation provide useful estimates of current higher water level expected at the property due to tides (Table 1). Storm surge and waves further increase water level causing greater potential inundation above tides, presented in Table 2. The storm surge and wave height data come from two recent studies from the Pacific Northwest National Laboratory (PNNL) (Yang et al., 2020, 2019).

Table 2. Local model estimates of flood and storm conditions relative to predicted tide levels.

Condition	Height (FT)
Storm Surge	2.6
Wave Height (Hs)	2.2

The storm surge value here (2.6 FT) may be an overestimate; these data are not certain as the closest continuous water level gauge is in Port Townsend. Investigation of the two largest storms in recent years, March 10, 2016 and December 20, 2018, revealed that water levels reached 2.2 FT and 2.3 FT above predicted tide levels in Port Townsend. Both higher tides and storm surge occur more often but usually do not perfectly coincide.

Future Sea Level Rise

In 2018, the Washington Coastal Resilience Project (WCRP) published updated projection of relative SLR which incorporates absolute sea level rise (SLR) and vertical land movement (uplift and subsidence) for Washington State (Miller et al., 2018). For this analysis we assessed two scenarios from this study based on the high greenhouse gas scenario RCP 8.5 for 2050 and 2100 (Table 3), which is understood to be the scenario represented by current trends. We assessed the 50% and 1% probability of exceedance, or the percent change that absolute sea level will rise by at least that amount.

Table 3. Sea level rise scenarios and local projected magnitudes (Miller et al. 2018) assessed in this report.

Scenario	Sea Level Rise (FT)
2050 RCP 8.5 50%	0.8
2050 RCP 8.5 1%	1.5
2100 RCP 8.5 50%	2.2
2100 RCP 8.5 1%	5.1

To assess SLR at this site we combined current conditions and SLR predictions to estimate water levels for 2050 and 2100 (Tables 4 and 5). Combining MHHW with SLR gives a good estimate of the average future high tides at the property, whereas HAT plus SLR estimates the highest water levels of a multi-decade period due to tides alone. Lastly, we combined MHHW with storm conditions and SLR as a projected worst-case scenario to characterize future storm conditions possible at the property.

Table 4. Predicted water levels by 2050 and 2100 for RCP 8.5 50% probability scenario.

2050	FT Above MLLW
MHHW + SLR	9.3
HAT + SLR	10.8
MHHW + Storm Surge + Hs + SLR	14.1
2100	
MHHW + SLR	10.7
HAT + SLR	12.2
MHHW + Storm Surge + Hs + SLR	15.5

Table 5. Predicted water levels by 2050 and 2100 for RCP 8.5 1% probability scenario.

2050	FT Above MLLW
MHHW + SLR	10.0
HAT + SLR	11.5
MHHW + Storm Surge + Hs + SLR	14.8
2100	
MHHW + SLR	13.6
HAT + SLR	15.1
MHHW + Storm Surge + Hs + SLR	18.4

This beach was noted to have been particularly impacted by the December 20, 2018 high water event, which had an estimated peak still water level on the order of 11.15 FT MLLW (still water level) at the Port Townsend tide gauge station. Waves would have been at least several feet higher breaking on the upper beach and backshore. Beach sediment was likely moved both offshore and alongshore to the northwest during the storm. This storm was described by Admiral Cove Beach Club committee members to have eroded approximately 20 horizontal feet of the backshore with loss of vegetation and displacement of the high storm berm and logs directly in front of the pool. This storm also reportedly deposited a substantial amount of drift logs in the backshore and lawn area of the site.

Shore Change Analysis

Aerial photos and maps were collected and reviewed to analyze erosional trends and document the historic configuration of the Admirals Cove Beach Club shores. These included aerial photos from the United States Department of Agriculture (USDA), the Whidbey Island Historic Photo App, and the USGS EROS Archive. We also visited Island County Public Works and gained access to the vault to scan selected historical vertical aerial photos. Table 6 summarizes the data sources.

Table 6. Historical aerial photo and map sources used in the shore change analysis.

Year	Source	Resolution	Scale or Pixel Size	Type (digital color/color scan/ black and white scan)
1942	US War Department	1 meter	1:24,000	Black and white scan
1963	Whidbey Island Historic Photo App	0.7 meter	1:12,000	Black and white scan
1983	Island County Public Works/WDNR(?)	0.5 meter	1:12,000	Color scan
2006	USDA/NAIP	1 meter	1 meter	Digital color
2009	USGS EROS Archive	0.3 meter	0.3 meter	Digital color
2017	USDA/NAIP	1 meter	1 meter	Digital color
2019	USDA/NAIP	0.6 meter	0.6 meter	Digital color

The digital images were imported into ArcGIS software along with post-processed GPS data collected during our field visit. The historic waterward vegetation lines were mapped as a proxy for shoreline position. This line was used as no other clear features were evident in many air photos. The beach here is coarse gravel without a definitive break in slope and without a wet-dry line as is sometimes used in this type of analysis (Moore, 2000; Morton, 1991).

Using the USGS Digital Shoreline Analysis System (DSAS) (Thieler et al., 2017) tool we calculated the Net Shoreline Movement (NSM) (Table 7) and End Point Rate (EPR) (Table 8) across six transects (Figure 4). The NSM is the distance between the oldest and youngest shoreline and the EPR is the NSM dividing by the time elapsed. We analyzed the entire time span, from 1963 to 2020, as well as the last decade, from 2009 to 2019. Rates for the last decade give a good understanding of recent and current erosion rates. These annualized rates represent average rate of change across the time period. In most cases in the region, erosion occurs episodically in change events such as high water and winter storm events followed by periods of relative stability.

Table 7. Net shoreline movement for six transects along the property shoreline (Figure 4) for two timespans. Negative numbers represent erosion, or landward shoreline movement.

Years	Net Shoreline Movement (FT)					
	A	B	C	D	E	F
1963-2020	-6.80	-8.20	-9.91	-11.52	-11.19	-35.10
2009-2019	4.27	1.38	-22.34	-21.52	-18.80	-18.21

Table 8. End point rates for six transects along the property shoreline (Figure 4) for two timespans. Negative numbers represent erosion, or landward shoreline movement.

Years	End Point Rate (FT/YR)					
	A	B	C	D	E	F
1963-2020	-0.13	-0.13	-0.16	-0.16	-0.20	-0.02
2009-2019	0.42	0.13	-2.16	-2.10	-1.84	-1.77

As there are limited ways to map the shoreline in older aerial photos with the steep gravel beach and variable image quality and georeferencing, only one shoreline proxy was available for shore change analysis for this property. Shoreline vegetation along this stretch varies along short distances and between years and seasons. It appears that the vegetation extended further waterward in 2020 than in 2019, indicating that vegetation may be regrowing after substantial losses during the December 20, 2018 storm. Just south of the property, on the south side of the fence, beach wrack and drift logs extended into the backshore moving the vegetation line substantially as measured along Transect F (Figure 4), likely from a recent high-water event associated with King Tides.

Total horizontal erosion shown in Table 7 was modest in the full time period (1963-2020) but was substantial in the recent decade. Rates shown in Table 8 were also substantial at around 2 FT/YR in the greater pool area in the recent decade.

Additionally, a series of low altitude, oblique angle photographs were compiled from the Washington Department of Ecology in Photo Page 2. These span from 1993 to 2016. The backshore vegetation area can be seen to be fairly wide and very dense in the 1993 photo. This area narrows along the southeast corner of the pool area by 2001. Little changes are observed through to 2006, with the exception of a dense accumulation of drift logs present in 2006. The 2016 photo shows substantial degradation in the backshore vegetation area, likely a result of the March 10, 2016 storm and initial re-growth. The newer air and ground photos show a considerably reduced backshore area after 2016.

Conclusions and Recommendations

Overall Conclusion

Based on review of local data and site observations, the subject property appears to be in an active and dynamic beach area. The property is quite low and subjected to wave energy and intermittent coastal erosion. The site is subjected to high wave energy and will be subjected to accelerated sea level rise as time goes on, which will also contribute to coastal erosion.

With no action taken, it is concluded that the pool enclosure/fence and concrete deck would more likely than not be subjected to damage within the next three years, as winter storms at high water are anticipated to be more frequent than during the historical record, based on recent trends. Starting in March 2016, the region has experienced three substantial windstorms at very high-water levels (March 2016, Dec. 2018, and Jan. 2021), which are tentatively considered 10-20 plus year (recurrence interval) storm events using the historical record leading up to the 2016 event. This seems to indicate an increase in storminess. These high-water events that coincide with southerly windstorms cause coastal erosion and damage to wood and other structures due to log impact and direct wave erosion. Conditions will get worse for potential damage with sea level rise. Under these conditions, the conditions are severe enough to warrant hard shore protection (hard armor, also called a bulkhead) waterward of the pool area.

The site is determined to have too high of wave energy for soft shore protection to be effective over time (Johannessen et al., 2014). The backshore width is too narrow and dynamic in front of the pool area for soft shore protection approaches to be considered feasible. This includes berm enhancement through beach nourishment along with other potential measures of large wood placement/anchoring, and vegetation.

A rock wall is proposed as the best general type of hard armor for shore protection for the pool area. This could be a sloping rock revetment or a steeper rockery wall. The armor we suggest would be as narrow as feasible and only in front of the pool building area to minimize impacts. Beach access on either end of the pool area would not be changed. As there are no other structures that are at risk close by, there is no justification to continue the rock wall all the way across the property's shoreline. We also evaluated the field northwest of the pool area and the septic drainfield appears to be setback far enough that armor protection is not necessary. Generally, the armor type and design would be to primarily mitigate storm damage going into the future as chronic beach erosion has not occurred to date at the site. Additional evaluation of the pros and cons of these different types of hard structures should be evaluated by a qualified coastal engineer. A site-specific design would then be developed.

Policy Discussion

New shoreline stabilization must conform to the applicable standards of the Island County Shoreline Master Program (SMP) if there is documented need to protect an existing primary structure or appurtenance. Key elements of the SMP relative to Shoreline Stabilization code, ICC 17.05A.110, are discussed here in terms of the coastal geologic issues and generally proposed hard armor at the subject property.

Regulation for shoreline stabilization may be permitted only when based on a geotechnical analysis and biological site assessment that "*The erosion creating the need for shoreline stabilization is not caused by upland conditions on the project site, such as the loss of vegetation or modification of drainage*" (ICC

17.05A.110.A1). Erosion and damage at this property are caused by storm waves and storm surge. There is no causation from upland sources as upland drainage is controlled with a drainage outfall that is released at the adjacent tidelands. Additionally, there is no slope that could be eroded or otherwise weakened by upland drainage.

New shoreline stabilization shall only be permitted when there is "*conclusive evidence documented by a geotechnical or coastal engineering analysis that erosion from wave or currents is expected to cause damage to a primary structure or appurtenance within three (3) years based on a trend analysis of prior rates of erosion if the shoreline stabilization is not constructed, or where waiting until the need is that immediate would foreclose the opportunity to use measures that avoid impacts to ecological functions*" (ICC 17.05A.110.A3c(v)). From the above site conditions, the property is exposed to a maximum fetch of over 13.7 miles from the south. The high wave energy at the site during southerly and south-southwesterly windstorms, and with transport of large logs, erosion, backshore damage, and projected sea level rise and apparent increased storminess, damage reaching the pool area will likely occur again in the next three years with no change.

Based on our shoreline change analysis, longer term erosion rates (1963-2020) were upwards of 0.2 FT/YR and shorter-term rates (2009-2019) had a maximum rate of 2.16 FT/YR. As the high elevation area with the pool area only extended only 2.0 FT waterward of the pool enclosure fence and concrete deck, it is reasonable to assume that without new shore stabilization the shoreline will be eroded completely back to the fence within the next few years.

Limitations of This Report

This report was prepared for the specific conditions present at the subject property to meet the needs of specific individuals. No one other than the landowner and their agents should apply this report for any purposes other than that originally contemplated without first conferring with the geologist that prepared this report. The findings and recommendations presented in this report were reached based on a brief field visit. The report does not reflect detailed examination of sub-surface conditions, or drainage system designs, which are not known to exist. It is based on examination of surface features, bank exposures, soil characteristics, gross vegetation characteristics, and beach processes. In addition, conditions may change at the site due to human influences, floods, groundwater regime changes, or other factors. This report may not be all that is required to carry out recommended actions.

References

Coastal Geologic Services, 2017. Beach Strategies Phase 1 Summary Report: Identifying Target Beaches to Restore and Protect (Prepared for the Estuary and Salmon Restoration Program No. 14–2308). Bellingham, WA.

Johannessen, J., Chase, M.A., 2005. FINAL Technical Memorandum: Whatcom County Feeder Bluff Mapping and Drift Cell Ranking Analysis (Prepared for: Parametrix Inc. and Whatcom County Planning and Development Services). Coastal Geologic Services, Inc., Bellingham, WA.

Johannessen, J.W., MacLennan, A., 2007. Beaches and Bluffs of Puget Sound (Puget Sound Nearshore Partnership Report 2007-04), Valued Ecosystem Components. Washington Sea Grant Program, University of Washington, Seattle, WA.

Johannessen, J.W., MacLennan, A.J., Blue, A., Waggoner, J., Williams, S., Gerstel, W., Barnard, R., Carman, R., Shipman, H., 2014. Marine Shoreline Design Guidelines. Department of Fish and Wildlife, Olympia, WA.

Miller, I.M., Morgan, H., Mauger, G., Newton, T., Weldon, R., Schmidt, D., Welch, M., Grossman, E.E., 2018. Projected Sea Level Rise for Washington State - A 2018 Assessment. A collaboration of Washington Sea

Grant, University of Washington Climate Impacts Group, University of Oregon, University of Washington, and US Geological Survey. Prepared for the Washington Coastal Resilience Project.

Moore, L.J., 2000. Shoreline Mapping Techniques. Journal of Coastal Research 16, 111–124.

Morton, R.A., 1991. Accurate shoreline mapping: past, present, and future, in: Coastal Sediments. Presented at the Specialty Conference on Quantitative Approaches to Coastal Sediment Processes, American Society of Civil Engineers, Seattle, WA, pp. 997–1010.

Polenz, M., Schasse, H.W., Kalk, M.L., Petersen, B.B., 2009. Geologic Map of the Camano 7.5-minute Quadrangle, Island County, Washington: Washington Division of Geology and Earth Resources Geologic Map GM-68, 1 sheet, scale 1:24,000.

Thieler, E.R., Himmelstoss, E.A., Zichichi, J.L., Ergul, A., 2017. The Digital Shoreline Analysis System (DSAS) Version 4.0–An ArcGIS Extension for Calculating Shoreline Change (ver. 4.4, July 2017) (U.S. Geological Survey Open-File Report No. 2008–1278).

WDOE, 1979. Coastal Zone Atlas of Washington: Volume 4, Island County.

Yang, Z., Garcia-Medina, G., Wu, W.C., Wang, T., Leung, L.R., Castrucci, L., Mauger, G.S., 2019. Modeling analysis of the swell and wind-sea climate in the Salish Sea. Estuarine, Coastal and Shelf Science, 224, 289–300. https://doi.org/10.1016/j.ecss.2019.04.043

Yang, Z., Wang, T., Castrucci, L., Miller, I., 2020. Modeling assessment of storm surge in the Salish Sea. Estuarine, Coastal and Shelf Science 238, 106552. https://doi.org/10.1016/j.ecss.2019.106552

ATTACHMENTS

Figure 1. Net shore-drift and location map.

Figure 2. Site Map.

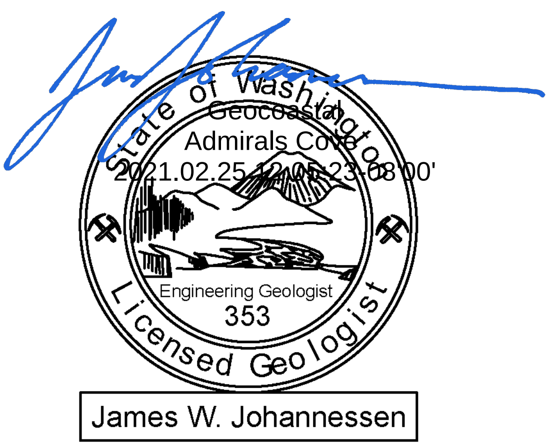
Figure 3. Surficial geologic units.

Figure 4. Historic vegetation line shoreline change map form 1963 – 2020.

Photo Page 1. Ground photographs of the project area taken December 18, 2020.

Photo Page 2. Historical aerial oblique photo compilation of the site.

Coastal Geologic Services. Inc.



Jim Johannessen,

Licensed Engineering Geologist and MS

Avery Maverick

Coastal Geologist, GIT and MS

Figure 1. Net shore-drift and location map in the vicinity of the subject property. Direction of net shore-drift reported from the perspective of the water facing the shore.

Admiral's Cove Beach Club Geocoastal/Geotechnical Report

COASTAL GEOLOGIC SERVICES

Figure 2. Site map.

Admiral's Cove Beach Club Geocoastal/Geotechnical Report

COASTAL GEOLOGIC SERVICES

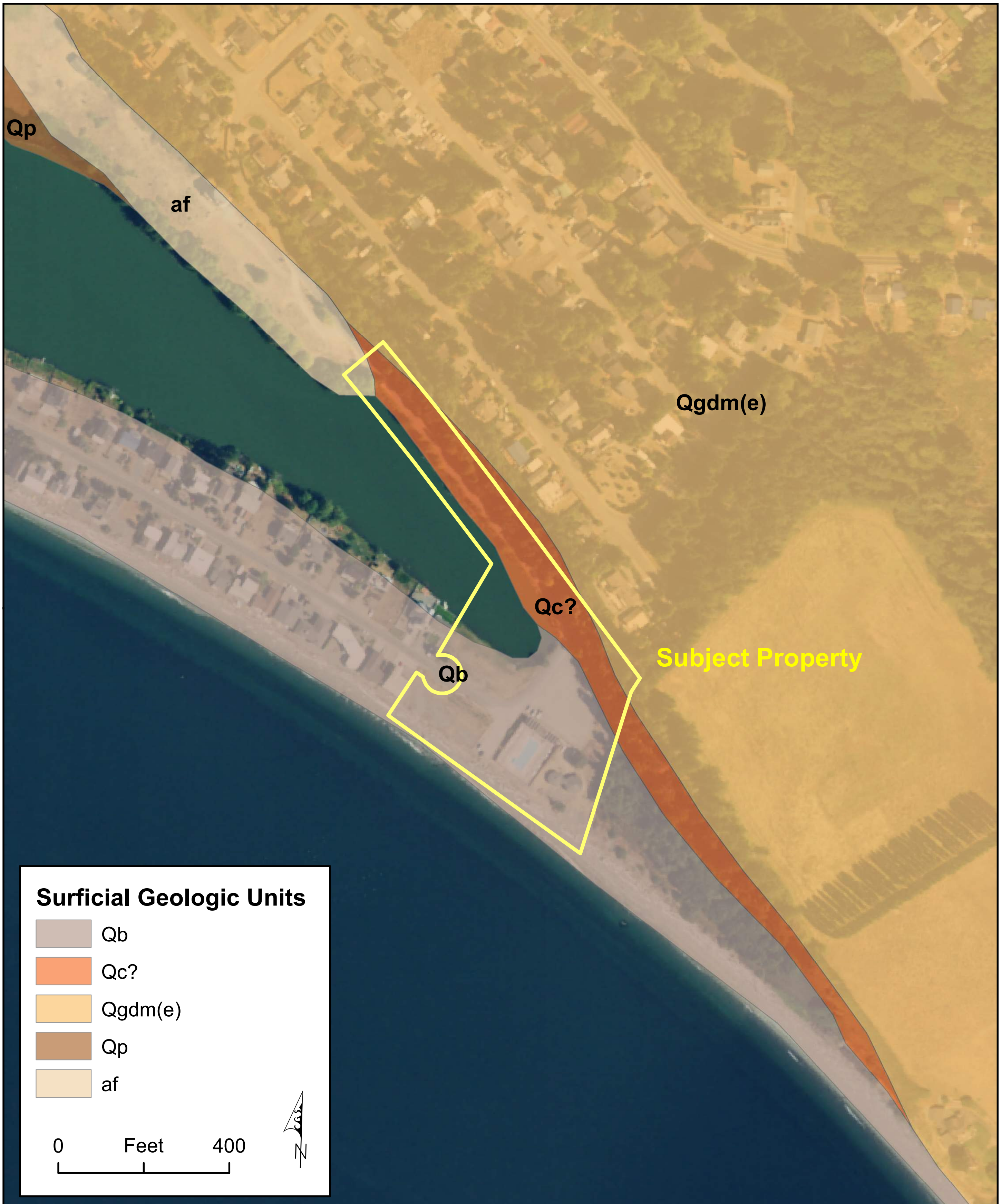


Figure 3. Surficial geologic units in the vacinity of the subject property.
Data from WA DNR, Polenz et al. (2009).
Admiral's Cove Beach Club Geocoastal/Geotechnical Report

COASTAL GEOLOGIC SERVICES

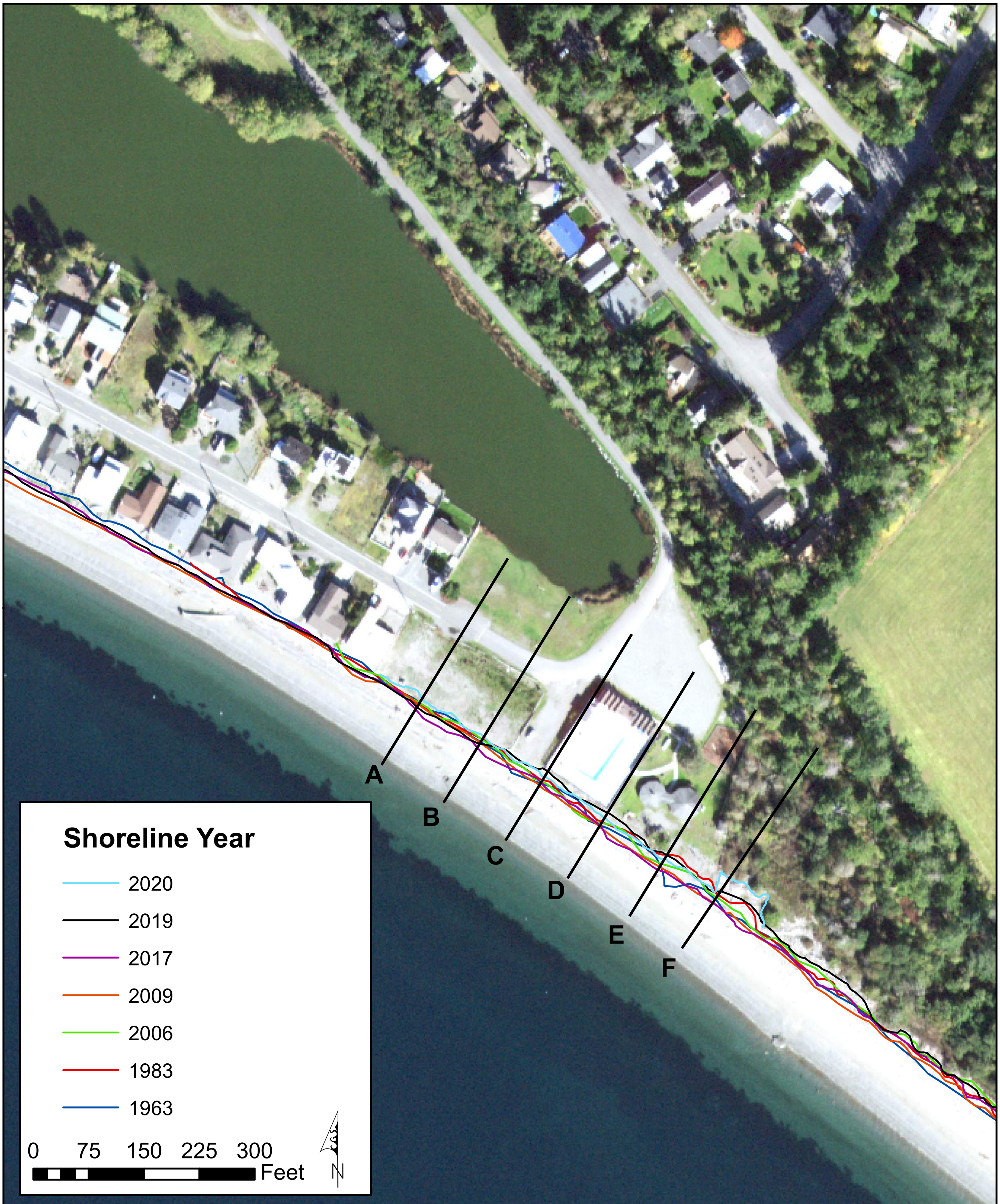


Figure 1. Historic vegetation line shoreline change map from 1963 - 2020. Imagery from USGS EarthExplorer, NAIP/USDA, Whidbey Island CD Historic Photo APP, Island Co. Public Works.

COASTAL GEOLOGIC SERVICES

Admirals Cove Geotechnical Report

Uplands with pool on the left and buildings on the right, looking northeast.

Uplands from between Keystone Ave and Admirals Lagoon, looking southwest. Septic drainfield in the right far field.

Uplands and upper beach looking southeast.

Uplands and upper beach with log line, looking northwest.

Waterward side of pool fence and upper beach, looking southeast.

Beach from near south property boundary, looking northwest.

Photo Page 1. Ground photographs of the project area taken 12/18/2020.

Photo Page 2a. 2016 aerial oblique taken 7/25/2016.

Photo Page 2b. 2006 aerial oblique taken 6/29/2006.

Photo Page 2c. 2001 aerial oblique taken 4/11/2001.

Photo Page 2d. 1993 aerial oblique taken in 1993.

Photo Page 2. Historical aerial oblique compilation of the site (Washington Department of Ecology).