



September 17, 1997

Crystal Waters Beach Owners
c/o Don Rathborne
13880 Mayfield Place
Richmond, BC
V6A 2E4 Canada

Attn: Don C. Rathborne

Re: Field Observations and Recommendations for Drainage Remediation
Crystal Waters Beach Development Area
Point Roberts, Washington

Dear Mr. Rathborne:

W.D. Purnell and Associates, Inc., is pleased to present our field observations and preliminary recommendations for drainage remediation within the Crystal Waters Beach Development area.

A geotechnical engineer from W.D. Purnell and Associates conducted a site visit with Don Rathborne and Cameron Scott (July 18, 1997). A second site visit was made (August 22, 1995) to clarify some issues. During the first site visit, we observed evidence of surface and shallow ground water problems throughout much of the development. We also observed bluff failures at several locations.

The purpose of this report is to summarize our field observations regarding drainage issues at the development and provide recommendations to collect and remove surface water and surface seeps associated with shallow ground water from the site, and improve the stability of the bluff in the community area to the south of the site.

It is our understanding that Crystal Beach Road (between A.P.A. Road and Waters Road), Waters Road, East and West Saturna Place, and East and West Waldron Place are all County roads. As such, Whatcom County is responsible for providing drainage along these roads.

FIELD OBSERVATIONS

Our field observations for each of the roads in the Crystal Waters Beach Development area summarized in the following sections.

Crystal Beach Road/Crystal Drive

Crystal Beach Road is ditched on both sides from its junction with A.P.A. Road to Waters Road, as is Crystal Drive north of Holiday Lane. The ditches to the north of Waters Road are in relatively good condition, but the ditches south of Waters Road are generally smaller and somewhat constricted by tree roots and other vegetation. The ditches south of Waters Road are largely covered on the east side. The water is transferred to

GEOLOGISTS • ENGINEERS • SCIENTISTS

September 17, 1997

Crystal Beach Development

Field Observations and Recommendations For Drainage Remediation

a 9-inch concrete pipe at Holiday Lane. This line continues to the south toward the top of the bluff. The water is transferred to a 6-inch corrugated pipe at the top of the bluff, where it is conducted down the bluff and released into the underbrush just above the Ordinary High Water Mark (OHWM). According to Don Rathborne, the 6-inch line does not overflow during typical rainy season conditions. The pipe did overflow during the last New Year period, when the 6-inch corrugated line became plugged. Overflow from the line may have helped cause a slope failure in the vicinity of the stairs to the beach which occurred on January 1, 1997.

Ground water seeps were observed to the west of Crystal Beach Road, on the vacant lot (Lot 5) immediately South of A.P.A. Road.

Waters Road

Waters Road, a Whatcom County Road, is not ditched along any of its length. The road does not extend beyond the west edge of the development.

Robert Drive

No drainage was observed along Robert Drive to the north of Holiday Lane. Surface water is collected in an area drain at Holiday Lane and conducted south to the Community property via a 9-inch concrete pipe. Water is then transferred toward the east and is conducted down the bluff. The down-bluff transport line was not observed, but it may have been damaged during the bluff failure event near the stairs that occurred during the past winter.

Holiday Lane

No complete drainage features were observed along Holiday Lane. Dry wells were observed on the north side of Holiday Lane, between Roberts Drive and Crystal Drive, and on the south side of the intersection of Holiday Lane and Sylvia Drive. The dry wells consist of 2-foot-wide and 2-foot-deep manholes, equipped with covers that are closed (west well), or grated (east well). The manholes are connected to 4-inch perforated PVC pipes that extend to the east and west. The manhole at Sylvia Drive also has a sealed opening to the southwest, which may have been intended to connect to a drain leading to the bluff. The dry wells serve to collect some surface water and infiltrate it into the ground, due to the head of water in the well. The dry wells have the potential to overflow during sustained wet periods.

We understand, based on information provided by Donn Aven, that there is a drain line extending along the south side of Holiday Lane to the east of Crystal Drive, and that this line empties into the drain alongside Crystal Drive.

A 4-inch perforated corrugated pipe was observed extending to the east from the ditch at the northeast corner of Holiday Lane and Crystal Drive. The area drained by the pipe was not determined.

West Saturna and Waldron Places

West Saturna and Waldron Places are poorly ditched on the north side. Drainage from portions of the cul-de-sacs was formerly directed to the ditch on the west side of the development. The drainage pipes were not observed, and may still be functional. The ditches on the north side, at Crystal Beach Road, are deep, connected with Crystal Beach Road, and collect water from the side streets, however they shallow rapidly as the ditches extend to the west. The result is that there is not an effective ditch toward which runoff can be directed on the north side of the cul-de-sacs.

East Saturna Place

Saturna Place is adequately ditched to the east side of the cul-de-sac. Culverts are provided under all driveways and the property owner to the east of the cul-de-sac has constructed a shallow drain to conduct surface water from the yard area to the ditch.

East Waldron Place

East Waldron Place is ditched, on the north side, for only a portion of the road toward the cul-de-sac. This appears to result in surface water passing over and around the east end of the road. Land on the south side of the road is significantly lower than on the north side and landowners around the cul-de-sac have complained of seasonal surface flows and inundation.

West Side Ditch

A shallow ditch was observed at several locations on the west side of the development. The drainage feature consists alternatively of open ditches, box culverts, and 9-inch concrete pipes, and passes near and under some residences and outbuildings. The drainage is contained in 9-inch concrete drainpipes through the Community property area to the south of Lot 1 and Holiday Lane. At the top of the bluff, the water is transferred to a short length of High Density Polyethylene (HDPE) corrugated pipe and transmitted down a portion of the bluff. Water is then transferred to a 6-inch corrugated pipe, that is set in a V-shaped trough, set on wood supports, which transfers water to the beach just below the OHWM.

East Side of Development, East of Sylvia Drive and South of Holiday Lane

No down-bluff transport lines were observed in the Community area. Shallow indications of surface flow were observed in the area.

Highland Drive and the Pasture Area East of Crystal Waters Beach Development

Highland Drive was observed to be adequately ditched on both sides of the road. A drainage line at the south end of the road collects water from the ditches and transports it down the bluff. The outfall structure was not observed.

September 17, 1997
Crystal Beach Development
Field Observations and Recommendations For Drainage Remediation

The land between the Crystal Waters Beach Development and Highland Drive occupied by a few residential lots and pasture land with associated outbuildings. A portion of the area west of Highland Drive is a shallow basin, which may collect water then discharge it to Crystal Waters Beach Properties in the vicinity of East Saturna and Waldron Places.

The first property south of A.P.A. Road on the west side of Highland Drive appears to block any water flowing in the ditch adjacent to Highland Drive. No culvert was observed to be passing under the driveway and the east portion of the lawn. The culvert, however, may be plugged by shallow soil failures on the north side and hidden from view by tall grass in the ditch on the south side. If the culvert is blocked, water from the ditch may add to runoff which ponds in the shallow basin contained in the pasture to the east of Crystal Waters Beach Development.

Bluff Area

The bluff materials consist of interbedded silt, sand, and gravel with occasional boulders, that have been overconsolidated (compacted by the weight of glacial ice). The overconsolidation allows the bluff to stand at an angle that is steeper than the typical angle of repose for the material.

The elevation of the bluff, taken from the topographic map, rises from approximately 40 feet on the west end to nearly 60 feet at the east end of the Crystal Waters Beach Development. The datum for the map is the Mean Lower Low Water (MLLW), which lies approximately 8 to 10 feet below the OHWM, as indicated on the site by the lower line of the upland vegetation. Actual elevations were not measured by our representative, but may be somewhat lower than those indicated on the topographic map.

General Observations and Considerations

According to the topographic map for the area, the land slopes to the southwest. While this is generally true, local variations result in some flat areas and reversed slopes. This feature may be helpful for diverting southwesterly flowing water away from the eastern portion of the development.

The site is bounded by ditched roads on the uphill side (north and east). The roadside ditches prevent surface water entering from areas to the north and east of A.P.A. Road and Highland Drive, respectively. Surface water which is causing problems, therefore, is falling within the area bounded by the aforementioned roads. As indicated earlier, ground water seeps within the development are adding to the surface water problem and may be a significant source of surface water during certain portions of the year.

The water used by residents of Crystal Beach is supplied by an outside source (GVRD), rather than groundwater that is removed from an underlying aquifer at the site. Virtually all of the water consumed at the site, with the exception of some lawn watering and car washing, infiltrates into the ground surface through the on-site septic systems which serve the area. Domestic wastewater usage tends to be small when compared with

September 17, 1997

Crystal Beach Development

Field Observations and Recommendations For Drainage Remediation

the amount of rainwater impacting the site, but the incremental amount of water adds to that which is transported through the ground to the face of the bluff, or expressed as ground water seeps at the site.

Soil failures observed on the face of the bluff are predominantly shallow surface failures that occurred due to soil saturation. The saturation may be the result of extraordinarily high amounts of precipitation, increased amounts of ground water seeping from the face of the bluff, or a combination of the two. The past two winters have been relatively wet, compared with preceding winters. At the end of 1996 and beginning of 1997, unusual weather patterns resulted in failures in several locations around bluff and steep slope areas located in Whatcom and Skagit Counties. Approximately 2 to 4 feet of snow fell between Christmas and the New Year.

On New Year's Eve, the weather warmed and approximately 2 inches of rain fell atop the snow. The weight of the snow and water load added significant weight to the already saturated soils. The added weight caused many marginally stable slopes to fail in the same manner as those at the Crystal Waters Beach Development. The unusual weather conditions also caused many drainage facilities to become blocked with ice and snow, resulting in increased overland flow of surface waters.

GOALS AND OBJECTIVES

The goal of this project is to alleviate surface water problems and retard erosion of the bluff at the south end of the development.

The objective is to recommend methods to alleviate surface water flooding and effective means to transmit water down the bluff. It is anticipated that water collection and down-bluff transport will alleviate some of the surface water effects on the ground water level and thereby reduce the frequency and severity of slides at the face of the bluff.

Prevention of slope failures on bluffs through construction of structural retaining devices tends to be rather expensive and difficult to permit. Active drainage of bluff groundwater prior to surface expression tends to be expensive and limited in effectiveness because cutoff trenches and drainage features may need to be installed to the deepest depth that groundwater problems are observed. As an alternative to that construction, we will recommend mitigation of the surface water problems at the site. We will recommend, in addition, that less desirable vegetation atop and on the face of the bluff be replaced with other vegetation with proven ability to help retain soils and maintain bluff stability.

RECOMMENDATIONS

This section lists our preliminary recommendations for the areas and problems described above. Where applicable, each area will be discussed individually as listed in the previous sections.

We recommend that drainage improvements be addressed sequentially, starting with improvements to the down-bluff transport lines and moving sequentially away from the top of the bluff. In this manner, the most critical elements for the development as a whole will be accomplished first. For example, we recommend that the down-bluff transport line be the first task, as a failed transport line has been implicated in previous failures

September 17, 1997
Crystal Beach Development
Field Observations and Recommendations For Drainage Remediation

at the site. If the County road drainage improvements are made as recommended below, relatively large amounts of runoff, which currently leave the site as surface runoff or shallow ground water, will be collected and transferred into the ditches along Crystal Drive, then the connector line to the down-bluff transport line. As a result, we recommend that repair/remediation items be addressed in the following order:

1. Repair of the down-bluff transport line(s);
2. Upgrade of the line from the ditches alongside Crystal Drive to the down-bluff transport line;
3. County remediation or construction of ditches along all County Roads;
4. Construction of ditches and or drainage features along private roads, and;
5. Revegetation of top and sides of bluff.

Down-bluff Transport Lines

We believe that the down-bluff transport line to the south of Crystal Drive is undersized for the quantity of water that may potentially be collected and discharged from the site. The line is not well founded atop the bluff. Connections between the existing lines are prone to leakage and may add to the potential for failure of the bluff soils.

We recommend that the down-bluff transport line be replaced with butt-welded HDPE pipe. Alternatively, double-wall, corrugated HDPE pipe (N-12) may be used. The N-12 pipe has a tendency to leak slightly at joints, but is less expensive and easier to install. The pipe should be founded a minimum of 12 inches below the soil surface on the top of the bluff. The pipe should be stabilized at the bottom of the bluff by enclosing it within a gabion or other similar structure such that it is not free to move at the downhill end. We also recommend that a quarry spill mat or other device be constructed at the end of the pipe to lessen the erosive force of the water exiting the pipe.

The diameter of the pipe will depend on the quantity of water that is conducted down the bluff. This will vary depending on whether off site water is brought onto the property for discharge below the bluff. If portions of the pasture west of Highland Drive are allowed to flow on-site, a larger sized pipe may be necessary. We have not yet modeled precipitation runoff in the area, which is necessary to calculate the pipe size requirements.

Depending on existing grades at the site, it may be possible and desirable to combine the down-bluff transport lines at Crystal Drive and Robert Road to reduce construction costs.

The down-bluff transport lines on the west side of the property and south of Robert Drive are prone to failure due to the type of installation used during the initial construction or subsequent upgrades. Portions of the Robert Drive down-bluff transport line may have been damaged during the bluff failure event during the past winter. Depending upon which courses of action the community decides to follow (and resultant quantities of water that are directed toward these areas), it may be possible to upgrade the transport lines using the same sized pipe that is currently used in these lines. Alternatively, the Community may decide to leave either or both of the lines in place, while making some repairs to help ensure that they will be adequate to their current task.

Connector Line: Crystal Drive to Down-bluff Transport Line

The line connecting Crystal Beach Drive with the existing down-bluff transport line has been adequate in the past. The line, however is on a relatively shallow slope, is relatively old, and appears to be constructed of short sections of concrete pipe, which may be prone to failure. We recommend that this line be upgraded to transmit anticipated flow volumes, based upon which options the community decides to pursue.

Whatcom County Roads

Drainage along Crystal Beach Road, as stated previously, is in relative good condition. The drainage ditches along East Saturna Place are in good condition and appear to be properly sized. We recommend that Whatcom County be requested to provide more substantial drainage ditches along West Saturna and East and West Waldron Places. The ditches should be constructed from the north side of the roads at their junction with Crystal Beach Road to terminus of the cul-de-sacs, or as far as possible.

We have not conducted site measurements to determine whether drainage ditches can be constructed on these streets, utilizing the existing culvert inlet invert elevations on the north side of the junctions of the respective streets with Crystal Beach Road. We believe the ditches can be constructed in at least some of the locations. If it is not possible to construct ditches as recommended, due to existing grades, it may be possible to construct drainages along the south sides of the cul-de-sacs and pipe stems to Crystal Beach Road.

Waters Road is currently without adequate drainage features. We recommend that the County be persuaded to install shallow ditches along one or both sides of Waters Road, from the east side of the development to the County ditches and connector boxes at Crystal Beach Road and Waters Road.

Waters Road from the west side of the development to Crystal Beach Road may not be able to be drained east toward Crystal Beach Road due to the existing grade. If not, we recommend that drainage in this area be conducted, via shallow ditches, to the shallow drainage path at the west side of the development. If such a connection is politically unfeasible, we recommend that the County be requested to construct drainage ditches that conduct runoff toward Roberts Drive. The development should then privately construct drainage ditches or underground pipe to convey the water from Waters Road to the existing catch basin at the corner of Holiday Lane and Roberts Drive.

County provided drainage remediation on all County roads should limit overland flow over much of the site, with the exception of those areas to the south of Waters Road, which are affected by run-on from the property to the east of Crystal Waters Beach.

Private Road Drainage

Evidence of shallow surface flows were noted near the southeast corner of the development, as indicated previously. We recommend that drainage be provided along Holiday Lane. Shallow ditches, constructed to

September 17, 1997
Crystal Beach Development
Field Observations and Recommendations For Drainage Remediation

Evidence of shallow surface flows were noted near the southeast corner of the development, as indicated previously. We recommend that drainage be provided along Holiday Lane. Shallow ditches, constructed to the south of Holiday Lane, can transmit water to the ditch alongside Crystal Drive. It is our opinion that the drainage on west end of Holiday Lane (west of Crystal Drive) can be split between Crystal Drive and the catch basin at the intersection of Holiday Lane and Roberts Drive.

Bluff Revegetation

Revegetation of the bluff top and face may be considered as a parallel project to drainage improvements at the site. As such, revegetation may be conducted simultaneously with other projects.

We recommend that non-native deleterious vegetation be removed from the bluff and that desirable vegetation be planted in its place. We observed that the top of the bluff is nearly entirely covered with grass. We recommend that the portions of the face of the bluff and the top of the bluff, for a distance of approximately 15 to 20 feet from the edge, be planted to vegetation that will develop a deep and interconnecting root mass. Certain plants will provide greater assistance than grasses to help hold bluff soils together without severely blocking the view. We recommend the use of snowberry, (*Symphoricarpos albus*), salal (*Gaultheria shallon*), kinnickinick (*Arctostaphylos Uva-ursa*), and evergreen huckleberry (*Vaccinium ovatum*). The plants listed are all less than six feet tall, thrive in full to partial sunlight, and tolerate salt spray. More vegetation recommendations will be made following subsequent visits to the site.

We recommend that the community obtain copies of three publications published by the Washington State Department of Ecology, which are designed to help bluff property owners with vegetation and slope management. These are: (1) Vegetation Management: A Guide for Puget Sound Bluff Property Owners (DOE Publication 93-31, May, 1993), (2) Slope Stabilization and Erosion Control Using Vegetation: A Manual of Practice for Coastal Property Owners (DOE Publication 93-30, May, 1993), and (3) Surface Water and Groundwater on Coastal Bluffs: A Guide for Puget Sound Property Owners (DOE Publication 95-107, June, 1995). These books may be obtained from the Department of Ecology at the following address:

Shorelines and Coastal Zone Management
Washington State Department of Ecology
P.O. Box 47600
Olympia WA 98504-7600

Telephone (DOE Publications) (360) 407-7472

Project Permit Considerations

Placement of new or repair of the existing outfall structures will require Hydraulic Project Approval by the Washington State Department of Fisheries and Wildlife (WDFW) and building permits from Whatcom County.

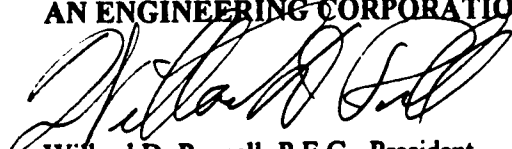
September 17, 1997
Crystal Beach Development
Field Observations and Recommendations For Drainage Remediation

We propose to let the community decide upon its intended course of action from among the above recommendations, or additional recommendations provided by community members. We anticipate that the community may wish to review some expected engineering costs for layout and engineers estimates of construction costs for some of these alternatives. We prefer to wait for community input, rather than trying to anticipate the alternatives that will be chosen and providing those cost estimates.

We appreciate the opportunity to submit these preliminary recommendations to you. If you have any questions, concerns or comments regarding these recommendations please contact Bob Bailey in our office, at (360) 676-9589, or toll-free at (800) 859-5597.

Sincerely yours,

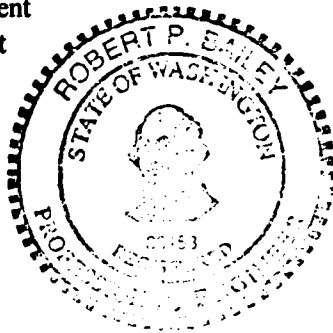
W.D. PURNELL & ASSOCIATES INC.
AN ENGINEERING CORPORATION



Willard D. Purnell, P.E.G., President
Professional Engineering Geologist



Robert P. Bailey, M.S.C.E., P.E.
Civil / Geotechnical Engineer



BB:bb

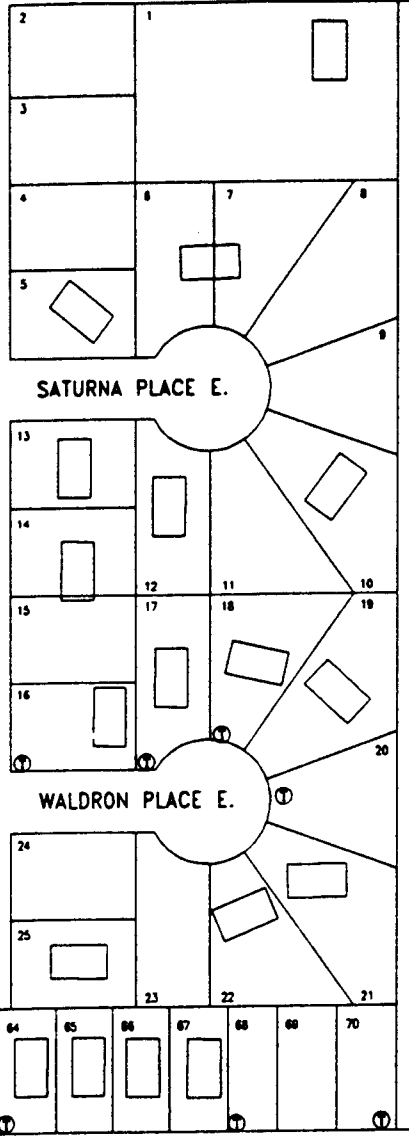
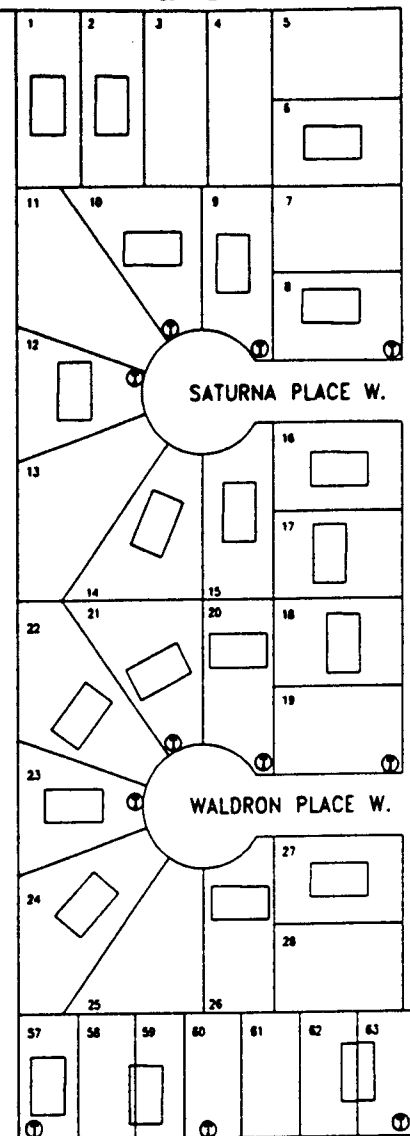
EXPIRES 11/21/1998

Attachments: Site Plan provided by Donn Aven

LOT 72

A.P.A. ROAD

LOT 71



WATERS ROAD

