A PRELIMINARY GROUNDWATER ASSESSMENT OF A CROWN LAND PARCEL ON HORNBY ISLAND - 1993

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Executive Summary

The subject Crown Land is 1,003 acres (406 hectares), and is located in the central upland area of Hornby Island on the eastern flank of Mount Geoffrey. A preliminary office groundwater assessment was conducted to determine whether the subject Crown Land is a recharge area and to determine the recharge sensitivity of the subject Crown Land. Because of the size and location of the subject Crown Land, all available hydrogeological information on Hornby Island was reviewed. Hydrogeological data are negligible in the upland areas and an exact delineation of the recharge areas was not possible at this time. Groundwater levels in the lowlands, and geologic and topographic considerations do, however, suggest that the upland areas including a significant portion of the subject Crown Land are important natural groundwater storage and catchment areas. These areas provide groundwater recharge to wells located within many of the surrounding lowlands of Hornby Island including the small-lot subdivisions where quality and quantity concerns exist. This preliminary assessment has shown that the upland areas including the subject Crown Land are both sensitive to groundwater recharge and vulnerable to threats of groundwater contamination and should be protected to help ensure preservation of the quantity and quality of groundwater on Hornby Island. The small lot subdivisions of Hornby Island have a high well density, are vulnerable to both groundwater contamination and reduced well capacities due to mutual well interference. Recommendations are made for further data collection, establishment of long-term monitoring networks, more detailed studies to understand the hydrogeology, and better management and protection of the groundwater resource on Hornby Island.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

A Preliminary Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993

1. Introduction

Hornby Island is located on the east side of Vancouver Island in the Strait of Georgia, approximately 125 miles (200 kilometres) north of Victoria, B.C. (Figure 1).

As requested by *Islands Trust*, a preliminary assessment of the importance of a 1,003 acre (406 hectare) Crown Land parcel as a "sensitive groundwater recharge area" for Hornby Island, has been carried out. The subject Crown Land is located within the central upland region of Hornby Island (Figure 2). Because of the size of this area and its location, this assessment has included a review of all available well record information on the island including the results of the 1992 *Islands Trust* questionnaire and field visits to the island. Major focus has been placed on the significance this Crown Land parcel has in terms of groundwater recharge, for small lot subdivisions (Sandpiper, Galleon Beach, Whaling Station Bay and between Shingle Spit and Phipps Point) where the majority of water wells are located and where most groundwater quantity and quality problems exist (Kohut et al, 1986).

This report discusses the general groundwater conditions of Hornby Island, the significance of the subject Crown Land parcel as a likely sensitive recharge area, and the hydrogeological relationship between the subject Crown Land area and small lot subdivisions in the regional discharge areas, where most groundwater development occurs.

1.1 Subject Crown Land Description

The subject Crown Land includes Portions of Section 2, 4, 5, 11, and 12 and is approximately 1,003 acres (406 hectares) representing 13.6 percent of Hornby Island's land surface. The total area of Hornby Island is 7,356 acres (2,977 hectares). The subject Crown Land is irregular in shape and is located in the centre of Hornby Island on the north-eastern flank of Mount Geoffrey (Figure 2). The upper boundary of the parcel exists at an approximate elevation of 580 feet (177 metres) above sea level, while the lower boundary exists at approximately 125 feet (38 metres). The land surface slopes from 18 percent along the upper boundary to about 3 percent near the lower boundary. The land is heavily forested with primarily second growth fir, cedar, and alder. Soil cover over bedrock is generally thin to absent at many locations.

1.2 Surficial Deposits

From field inspection, the surficial deposits in the subject Crown Land area range from thin to absent at higher elevations. Thicker alluvial deposits possibly derived from surrounding sandstone slopes are evident in some topographic troughs, while fine-grained sediments at these locations may have been deposited under marine conditions. Alluvial deposits are also evident at lower elevations near the mouth of Beulah and Ford Creeks (Figure 2).

Successful wells have been constructed in these surficial deposits where water bearing sand and gravel layers are interspersed between finer grained deposits. Groundwater has also been obtained from fractures in the underlying bedrock at these locations where the alluvium may provide storage for recharge to deeper bedrock aquifers. A direct hydraulic connection may exist between the overlying alluvium and the underlying bedrock in these locations.

1.3 Bedrock Geology

Hornby Island is underlain by a series of conglomerates, sandstones, shales, and siltstones, all belonging to the Nanaimo Group of Upper Cretaceous age (Figure 3 and Table 1). These strata dip gently towards the northeast. The bedrock geology of Hornby Island consists of five sedimentary bedrock formations. These formations have been designated as, from youngest to oldest: Gabriola, Spray, Geoffrey, Northumberland, and De Courcy Formations (Muller and Jeletsky,1970).

The Gabriola Formation is the youngest formation of the Nanaimo Group, consisting of medium-to-coarse grained massive sandstone with minor conglomerate. The Gabriola Formation underlies the Whaling Station Bay peninsula.

The Spray Formation, comprised of shale and sandstone underlies the Tribune Bay area and also the lowland area west of Mount Geoffrey. The name is derived from Spray Point, a resistant sandstone ledge projecting into the middle of the bay. The Spray Formation overlies the Geoffrey Formation. The lithology of the lower part of the Spray Formation, is similar to that of the Northumberland Formation.

The Geoffrey Formation is found in the centre of the island, east of Mount Geoffrey and underlies the subject Crown Land. The Geoffrey Formation is composed mainly of coarse conglomerate with minor sandstone.

The Northumberland Formation is exposed near the south end of Hornby Island at Ford Cove, between underlying De Courcy sandstone and overlying Geoffrey conglomerate, and at Galleon Beach. Less than 200 feet (61 metres) of the Northumberland Formation is exposed on Hornby Island. The lithology of the Northumberland shale is similar to that of the Spray Formation.

The De Courcy Formation occurs at Norman Point on the southern tip of

Hornby Island and on Norris Rocks southeast of that point. The De Courcy is a brown grey massive sandstone, in beds up to 10 feet (3 metres) thick, and separated by shale layers.

The bedrock geology of Hornby Island is both varied and complex. Groundwater occurs in and moves throughout the pores and / or openings in these rock formations. The rock types can vary significantly in their ability to store and transmit water. The openings can be intergrain pores in the sandstone or shales or, more likely, through openings in the fault zones, fractures and bedding planes (Groundwater Resources of British Columbia, 1993). Groundwater occurrence and movement is governed by local geology, availability of openings in the bedrock, recharge, and movement of water from areas of recharge towards points or areas of discharge (Driscoll, 1986).

1.4 Hydrologic Cycle and Groundwater Flow

An understanding of the hydrologic cycle and groundwater flow is necessary for recognizing the important connection between the Mount Geoffrey upland area and the surrounding lowlands on Hornby Island.

The hydrologic cycle refers to the circulation of water between the land, ocean, and atmosphere. Inflow of water to the land based portion of the hydrologic cycle occurs as precipitation whereas outflow leaves as streamflow and groundwater discharge to the ocean and evapotranspiration to the atmosphere (Driscoll, 1986). Between the inflow and outflow, some water travels as overland flow while some water infiltrates into the ground and travels as groundwater flow (Figure 4).

Gravity is the dominant driving force in groundwater movement. Groundwater typically flows downward from the recharge areas and upwards to the discharge areas (Figure 4). Steeper topographic slopes generally signify higher groundwater gradients. Topography can play a significant part in controlling the gradient and direction of groundwater flow because the form of the water table is often a subdued replica of the land surface (Freeze and Cherry, 1979).

1.5 Water Well Record Information

The Groundwater Section has 512 water well records on file for Hornby Island (Figure 5 and Appendix A). Water well records are also plotted on 1:5000 mapping. There may be a greater number of wells located on Hornby Island as submission of water well records is not mandatory. The 512 reported wells include those completed to January, 1992. Of this number, 86 percent or 439 wells, are drilled while the remaining 14 percent are dug wells or springs. Well frequency versus well depth is shown in Figure 6. The average depth of all drilled wells is 138 feet (42.1 metres) with the deepest well recorded as 500 feet (152.4 metres) at the Sandpiper Subdivision.

Sixty-six percent of drilled wells are located on lot sizes generally 1/2 acre (0.20 hectare) or less and are located within the small lot subdivisions of Hornby Island (Table 2). The majority of wells are completed in fractured bedrock and most wells are located within the lowland areas. Water levels are generally shallow with 80 percent of water levels recorded at the time of well completion as 20 feet (6.1 metres) or less below ground level.

Well frequency versus well yield is shown in Figure 7. The median reported well yield for all wells is 4 gallons per minute (0.25 litres per second). Thirty wells have yields of 20 gallons per minute (1.5 litres per second) or greater with the greatest well yield reported as 50 gallons per minute (3.8 litres per second) inland within the upland area off Slade Road west of Tribune Bay. Reported well yields are however, based on short-term bail tests conducted by drilling contractors at the time of well completion and may not be as accurate as pumping tests for determining long-term yields. It is important to note that only 2 wells appear to be located within the upland area covered by the subject Crown Land and Mount Geoffrey Regional Park. Direct groundwater data for assessing whether the subject Crown Land is in a sensitive recharge area are therefore, negligible.

1.6 Observation Well No. 288 Discussion

In 1984, the Groundwater Section constructed an observation well on Central Road located adjacent to the Sandpiper Subdivision. The well is 6-inch (152mm) diameter, 253 feet (77.1 metres) deep, and was rated at 5 gallons per hour (0.006 litres per second) by the well driller based on a short term bail test (Wei, 1985).

The well was constructed for the purpose of monitoring long-term response to aquifer recharge and local domestic well pumping. The well is equipped with an automatic water level recorder and protective steel recorder housing.

Continuous water level data has been collected since March, 1984. Month-end water levels have been manually digitized from the hydrographs, corrected to ground level, and plotted in Figure 8.

The seasonal water level fluctuation has ranged up to 18 feet (5.5 metres) with the lowest seasonal water levels occurring around October to November and the highest water levels occurring around March to April. Groundwater level fluctuations correlate with precipitation indicating the groundwater recharge on Hornby Island is from infiltration of precipitation. This interpretation is consistent with studies done for other fractured bedrock terrains in southern Vancouver Island (Kohut et al, 1984). Data collected suggest there is no long-term aquifer depletion occurring; however, water level response at this site may reflect regional groundwater conditions rather than local conditions. Examination of the actual hydrographs indicate that this well also responds to nearby pumping and ocean tides; these phenomena would not, however, be evident from the month-end plot in Figure 8.

2. Hydrogeology of the Subject Crown Land

The subject Crown Land is characterized by moderate to steep slopes, thin soil cover, and dipping fractured and layered conglomerate and sandstone. The bedrock formations of the Nanaimo Group form the principal aquifer system on Hornby Island. Groundwater is generally obtained from irregular fault planes, joints and fractures along bedding planes or where the rock is porous. Bedding plane fractures can range from horizontal to vertical. Where fractures are steeply dipping, significant groundwater recharge could occur. However the bedrock fracturing, may have limited storage capacity.

Soil conditions and topography also influence the amount of recharge to the aquifer. Thin soil cover suggests that there is limited opportunity for the surficial deposits to serve as a storage reservoir for the underlying bedrock. Surface water runoff within the subject Crown Land is likely significant; however, some recharge to the groundwater regime will occur when heavy rainfall forms intermittent streams or wetlands that remain on the surface long enough for water to infiltrate into the bedrock and recharge the aquifer.

Beulah and Ford Creeks and the wetlands surrounding these creeks may also be important. An important hydraulic relationship may exist between overland flow, these creeks, and the groundwater system of Hornby Island. During periods of heavy precipitation these creeks may provide significant quantities of surface water to recharge the groundwater. The amount of recharge available to the groundwater would depend largely on the permeability of the stream beds. Because of the possible heterogeneity in soil types at the ground surface over the watershed, certain portions of the watershed may regularly contribute overland flow to these creeks, whereas other portions may not. Unfortunately, much of the surface water may be lost to runoff during periods of heavy rainfall which normally occurs during the winter months (December to March), because the local groundwater table is relatively shallow and stream recharge to the underground may be minimal. During the summer months, however, groundwater may in turn discharge to Ford and Beulah Creeks to sustain creek flows.

2.1 Determining whether the Subject Crown Land is a Recharge Area

A recharge area, by definition, is where the net saturated flow is directed <u>into</u> the aquifer; in a recharge area, there is a downward component of groundwater flow (Freeze and Cherry, 1979). As a corollary, groundwater flows from recharge to discharge areas. By definition, a discharge area is where there is a net upward component of flow out of the aquifer.

There are several indicators for determining whether the Crown Land area is a recharge area:

1) directly from groundwater data (water levels, flow direction, and hydraulic gradient) and,
2) indirectly from topography,
3) depth to the water table,
4) groundwater chemistry, and
5) vegetation type and distribution.

2.1.1 Recharge Area Inferred Directly from Groundwater Levels, Flow Direction, and Hydraulic Gradient

Direct indicators of a recharge or discharge area are groundwater level measurements, flow directions, and hydraulic gradient. Lack of well data preclude the determination of flow directions in the upland area covering the subject Crown Land and Mount Geoffrey Regional Park areas. However, existing data within the surrounding lowland areas are useful for determining the general groundwater levels and flow directions in the bedrock aquifer system and allowing us to infer where groundwater flow is derived.

The regional groundwater level elevations have been estimated from land surface altitudes and historical water level measurements in wells. Groundwater levels have been contoured (Figure 9). Groundwater levels rise from sea level in the coastal lowland areas to greater than 150 feet (45.7 metres) above sea level inland and form a subdued replica of the land surface. Groundwater levels would represent the water table surface on Hornby Island assuming steady-state flow conditions and essentially horizontal flow. The groundwater levels in Figure 9 suggest regional groundwater flow directions are from the edge of the central upland area to the surrounding lowlands to the north and east. Groundwater flow from the upland area also likely occurs to the south and west, however groundwater levels in those areas are ill-defined due to lack of well data. Groundwater flow directions were inferred assuming the bedrock permeability is isotropic or uniform throughout.

Although no groundwater levels are available beneath the Mount Geoffrey Regional Park and subject Crown Land areas, the relationship between topography and groundwater level elevations from existing wells, suggests the highest groundwater level elevations would be expected in those areas (Figure 10). Negative groundwater elevations shown in Figure 10, however, may be affected by pumping conditions from wells located near coastal areas, slow recovery of the water level in low permeability bedrock after the well was drilled, or possible inaccuracy in well location.

Groundwater flow on Hornby Island is interpreted to be from the uplands towards the lowlands. The subject Crown Land, located in the upland area, therefore appears to be in the regional recharge area of the island. The radial groundwater flow direction inferred from the groundwater level contours suggests the upland area recharges the surrounding lowlands on Hornby Island, except perhaps Whaling Station Bay Peninsula. Recharge on Whaling Station Bay peninsula appears to be derived locally. Figure 11 is a cross sectional view of Hornby Island showing the groundwater flow occurring away from the upland area towards the lowland areas; from the recharge area to the discharge areas. Part of the subject Crown Land is shown on Figure 11 and appears to be within the upland area of recharge. Downward (vertical) flow measurements in the upland area are required to better define the recharge area.

2.1.2 Recharge Area Inferred Indirectly from Topography

Recharge areas can be inferred from the topography. According to Freeze and Cherry (1979), field observations in many areas typically show highlands are recharge areas and lowlands are discharge areas. This is because the water table often forms a subdued replica of the topography. Groundwater flow directions can be inferred from topography where direct water level measurements are unavailable. Figure 10 shows that groundwater elevations generally increase with increasing land elevation and the use of topography to infer recharge areas, in this case is reasonable. The topographic location of the subject Crown Land in the upland area suggests that it is in the recharge area.

2.1.3 Recharge Area Inferred Indirectly from Depth to Water

Areas of general ranges of depth to water in wells have been delineated to infer locations of recharge and discharge areas on Hornby Island (Figure 12). Generally, depth to water is greater in recharge areas and less in discharge areas (Freeze and Cherry, 1979). The coastal lowlands north and east of the upland area, characterized by shallow depth to water between 0 feet and 15 feet (0 metres and 4.5 metres), are interpreted as discharge areas. The regions of shallow groundwater include a small portion of the subject Crown Land. The deeper depth to water area between Shingle Spit and Norman Point reflects the presence of a high escarpment. This area, however, is also interpreted as a discharge area despite the deeper depth to water.

The greatest depth to water in the central upland area and covering much of the subject Crown Land (>100 feet or >30 metres) is interpreted to be a recharge area. This depth to water area, however, is <u>inferred</u> from groundwater level trends observed in Figures 10 and 11 as negligible data exist in the upland. The deeper depth to water at Whaling Station Peninsula is also interpreted as another recharge area.

An area of shallow depth to water lies at the headwater of Ford Creek, just west of the subject Crown Land. The location of this shallow groundwater area in the uplands suggests it may be a local discharge area which eventually recharges the aquifer further down gradient (Figure 13).

2.1.4 Recharge Area Inferred Indirectly from Groundwater Chemistry

Another indicator of a recharge or discharge area is water quality. A general observation is that pH and salinity (represented by total dissolved solids) generally increase along the groundwater flow path. Water in recharge areas is usually relatively fresh while water in discharge areas is more alkaline and saline (Freeze and Cherry, 1979). Unfortunately, no water quality information is presently available within the topographically high areas of Hornby Island and any chemical evolution of groundwater from recharge to discharge area can not be discerned from existing data.

2.1.5 Recharge Area Inferred Indirectly from Vegetation

Groundwater flow systems and relationships between recharge-discharge areas can also, in some cases, be inferred from land surface features such as location of springs and vegetation (Domenico and Schwartz, 1991; Freeze and Cherry, 1979). Review of 1:10,000 scale air photos ($_{30}$BCC911008) covering Hornby Island indicate that broadleaf maples grow along the base of the prominent escarpment directly west of Mount Geoffrey where springs (discharge features) are known to occur. Broadleaf maples typically grow in coarse, gravelly moist soils (Hosie, 1979) and although broadleaf maples do not appear to occur in large groves on the island, their occurrence in small stands, especially along slopes or break in slopes, may indicate areas of shallow groundwater (discharge areas) on the island. Areas uphill from these trees are interpreted as regional recharge areas where no significant discharge features are discernable. Delineating these uphill areas may be a qualitative and preliminary method of mapping recharge areas on the island in the absence of direct groundwater data.

Although red alder also grows in wet areas, occurrence of red alder on Hornby Island is ubiquitous and includes upland areas that were clear-cut or logged. As such, red alder was not used as the main tree species for differentiating between recharge and discharge areas. Alders may indicate wet areas or areas of shallow groundwater along steeper slopes where logging did not occur.

In delineating recharge areas, the areas uphill of broadleaf maple stands on Hornby Island were delineated from air photos and from 1:20,000 scale forest cover mapping (Forest Cover Mapping Series 92F.057); these upland areas are shown in Figure 14. Tree and plant species were spot-checked in the field.

The recharge area, as mapped from vegetation, covers Mount Geoffrey Regional Park and a significant portion of the subject Crown Land as well as the local upland area at Whaling Station Peninsula (Figure 14). The recharge boundary is more clearly defined west and south of Mount Geoffrey where topography and surface features are prominent; the recharge boundary northeast of Mount Geoffrey and along the eastern edge of the subject Crown Land is ill-defined because surface features are muted. Local discharge areas may exist at the north end of the subject Crown Land at Beulah Creek and at the headwater of Ford Creek. Figure 14 also shows that groundwater at Whaling Station Bay peninsula may be recharged locally from precipitation falling on the peninsula rather than from the Mount Geoffrey upland area.

The recharge areas inferred from vegetation generally coincide with areas of deeper groundwater in the upland region and at Whaling Station Bay peninsula (see Figure 12). The recharge boundaries, as defined, likely represent regional recharge areas. Other, more localized, recharge areas may occur downhill of the delineated boundaries. For example, the local valley at the head of Ford Creek may be an area of local groundwater discharge as indicated by the presence of broadleaf maples surrounding the valley. However, the valley area may in turn be within the area of regional recharge to the lowland areas further downstream, including the Sandpiper Subdivision area (Figure 13). Similarly, the areas at the base of the prominent escarpment west of Mount Geoffrey, including the 40-acre parcel in Hodge's (1992) previous assessment, may receive recharge from Mount Geoffrey but also provide recharge for areas further down gradient.

Although the upland region of Hornby Island appears to be a recharge area, it is not possible at this time to delineate the recharge area precisely because of limited data. The recharge boundaries, as delineated, are interpretive and preliminary. Detailed field mapping of springs and vegetation, together with direct groundwater level data, is required to more accurately define the recharge areas. Even then, recharge areas inferred from vegetation may only be feasible where surface features are prominent. However, the boundaries provide a first approximation of the recharge area on Hornby Island where direct groundwater data are lacking.

Springs exist on the steeply sloping west side of Mount Geoffrey Regional Park at about 230 feet (70 metres) elevation. These springs are discharge features and may represent the hinge line (the line that separates local recharge areas from discharge areas) in this local area. Spring activity is also apparent to the northeast and to the southeast of Mount Geoffrey Regional Park (Chwojka, 1984). Locating, mapping, and sampling natural spring activity is one method of delineating the recharge areas of Hornby Island on a regional scale.

2.2 Determining the Sensitivity of the Upland Recharge Area

To determine the sensitivity of the upland area to human activity requires a comprehensive examination of the bedrock and soil characteristics, land slope features and vegetation as well as the proposed activity and land use. As these characteristics can vary locally, so can the degree of sensitivity of an area. An understanding of how a specific contaminant travels and the velocity at which the contaminant is transported through this aquifer is also necessary in assessing sensitivity. In the absence of available data, vulnerability of the aquifer to contamination is inferred from 3 general factors: 1) level of hydraulic confinement of the aquifer, 2) effective porosity, and 3) likely attenuation of contaminants by the soil cover and bedrock.

The fractured bedrock aquifer exists under unconfined conditions. There does not appear to be any confining layer above the aquifer offering protection against contamination introduced at the land surface. Unconfined aquifers are therefore, generally considered more vulnerable to contamination from activities directly above the aquifer than confined aquifers, everything else being equal. Groundwater on Hornby Island flows down gradient from uplands to lowlands and the water table appears to be a subdued replica of the topography. The water table likely therefore has a steep hydraulic gradient locally. For example, if a contaminant were introduced by human activity, into the aquifer at the upland recharge area, the primary driving force for contaminant travel would be created by the hydraulic gradient in the aquifer. The steeper the hydraulic gradient, the quicker the contaminant would likely travel through the aquifer. Other factors, of course, come into consideration when assessing contaminant travel, such as the depth to water table, density of the contaminant in relation to water and how the contaminant reacts with the geologic medium.

Effective porosity affects the average linear velocity of groundwater and therefore transport of any contaminant (Freeze and Cherry, 1979). The lower the effective porosity of the aquifer, the higher the velocity. Effective porosity of fractured bedrock is typically an order of magnitude (or more) less than that of sand and gravel aquifers. The relatively low porosity of fractured bedrock may result in quicker transport of any contaminants.

Although the sandstone underlying the subject Crown Land may have low permeability, fractures in the rock and along bedding planes may act as preferred conduits for any contaminants placed on the land surface.

The thin soil cover and likely low porosity of the fractured bedrock in the central upland area likely offers limited attenuation capacity for any contaminants. The fact that the thin soil cover, having limited surface water retention capacity, overlies fractured bedrock having limited storage capacity and the water table has a steep hydraulic gradient show the important interconnecting hydrogeologic relationships that exist within the upland recharge area. This relationship suggests that the upland recharge area is also likely sensitive to groundwater recharge.

3. Vulnerability of Small Lot Residential Subdivisions

In addition to assessing whether the subject Crown Land is in a sensitive recharge area, the vulnerability of the discharge areas, particularly the small lot subdivisions where groundwater development occurs and which receive recharge from the upland areas are also discussed.

The majority of residents on Hornby Island live within small lot residential neighbourhoods. According to the May, 1990 Hornby Island Official Community Plan, there are 661 small lots of 1/2 acre (0.20 hectare) size or less in the residential neighbourhoods of Sandpiper, Galleon Beach, Whaling Station Bay, and the area between Shingle Spit and Phipps Point. These areas have been identified as being vulnerable to both groundwater contamination and for reduced well capacities due to mutual well interference (Chwojka, 1989).

The majority of developed properties have septic systems and drilled wells. Sewage contamination to groundwater and hydrogen sulphide gas are of concern. Continued development has also increased the likelihood of well interference, local decline of the groundwater level, and sea water intrusion.

A cursory discussion on the groundwater conditions and water quality within the major small lot residential areas is presented below:

3.1 Sandpiper Subdivision

The Sandpiper Subdivision is located directly east and downslope of the subject Crown Land. The subdivision exists at an elevation of 150 feet (46 metres) inland, with the land surface gradually sloping in an easterly direction towards the ocean (sea level).

The Groundwater Section has records of 132 wells constructed on small lots up to November, 1990 (Table 2). The average depth of wells is 129 feet (39.3 metres). The deepest well on record is 500 feet (152.4 metres). Some wells have been completed in surficial deposits around Ford Creek and to the north around Beulah Creek where alluvial materials have been deposited. Most wells, however, are completed in bedrock where groundwater is obtained from fractures in the bedrock or bedding planes.

The median reported bedrock well yield is 5 gallons per minute (0.31 litres per second). Most well capacities reported are estimated, based on short term bail tests carried out by the drilling contractor. The Mount Geoffrey area likely provides groundwater recharge to the Sandpiper Subdivision wells (Figures 9 and 14). Because of considerable surface water runoff, probable limited bedrock fracturing and thin soil cover, groundwater recharge to wells may, however, be limited.

Water quality degradation is a concern. Sewage contamination to groundwater, hydrogen sulphide gas, high iron and sea water intrusion problems are reported in wells located within the Sandpiper Subdivision.

Many homeowners use septic tank / leaching field systems to treat their sewage. Of the 71 groundwater questionnaire respondents within the Sandpiper subdivision, 43 households have septic tank / leaching field systems. Other residents use outhouses or chemical toilets. If a thin cover of poorly sorted soil and sloping bedrock below the soil are present as is evident in the area, some of the effluent may reach the sloping bedrock and migrate quickly and for a considerable distance along the soil / bedrock contact zone. Problems exist where a water supply (ie. well) may intersect the migration path. Seven groundwater questionnaire respondents reported above acceptable limits for total coliform detected in their water supplies. Homeowners may unknowingly contaminate their own water supplies through improperly located and defective systems; however a water supply may also be contaminated from a defective neighbouring system.

Hydrogen sulphide gas in wells located in the Sandpiper Subdivision is common (Kohut et al, 1986). During the field surveys carried out by the Groundwater Section in 1981 and 1982, many residents reported hydrogen sulphide gas in their water supplies. Eleven residents, responding to the 1992 *Islands Trust* groundwater questionnaire, reported the presence of hydrogen sulphide gas in their well water.

Salt water encroachment is suspected in some wells located within the Sandpiper Subdivision. On the groundwater questionnaire a few well owners report "salty water" in their wells. This situation may result from wells being located in close proximity to the ocean and high groundwater use, moving the fresh water / salt water interface inland and nearer the ground surface (upconing) thereby contaminating the groundwater.

3.2 Galleon Beach Subdivision

The Galleon Beach Subdivision is located north and downslope of the subject Crown Land. The Galleon Beach subdivision exists at an elevation of 80 feet (24.4 metres) above sea level inland with the land surface gradually sloping to the north to sea level.

The Groundwater Section has records of 56 wells constructed on small lots up to December 1991. The average depth of wells is 131 feet (40 metres). The deepest well on file is 300 feet (91 metres). All drilled wells are completed in bedrock where groundwater is obtained from fractures or bedding planes. Thicker overburden to 30 feet (9.1 metres) is evident to the east of the main subdivision. The average depth to water in wells is 15 feet (4.6 metres) below ground level. The median reported well yield is 3 gallons per minute (0.19 litres per second).

The subject Crown Land and Mount Geoffrey upland area is likely an important groundwater recharge area for wells located within the Galleon Beach Subdivision and neighbouring areas. Surface water entering the groundwater flow system eventually reaches the lowlands around Galleon Beach Subdivision and provides recharge to wells. Similar soil conditions, well density, spacing between wells, and land use (small lot subdivision) suggest that the Galleon Beach Subdivision may be experiencing similar septic disposal / well contamination problems already evident in the Sandpiper Subdivision.

Hydrogen sulphide gas in wells located in the Galleon Beach Subdivision is common. During the 1981 and 1982 field surveys, 22 water quality tests were conducted on wells located within the Galleon Beach Subdivision. Contamination to wells through sea water encroachment was generally not evident during these surveys. A few instances of elevated iron concentrations in well water were also reported.

3.3 Whaling Station Bay Subdivision

Whaling Station Bay Subdivision is a flat, low-lying area located between Tralee Point and Cape Gurney, and is somewhat geographically isolated from most of Hornby Island. The Groundwater Section has records of 85 wells constructed on small lots up to January,1992. The average depth of wells is 162 feet (49.4 metres) and the deepest well is 392 feet (119.5 metres). Because of limited recharge and poor water quality, community water wells have been established at Whaling Station Bay. Many of the 85 wells on record may be unused or abandoned. The median reported yield of bedrock wells located within Whaling Station Bay is 2 gallons per minute (0.13 Litres per second). Groundwater recharge to wells located at Whaling Station Bay may be limited mainly to precipitation entering into bedrock storage within the relatively small catchment area of the Whaling Station Bay peninsula. The fact that wells are on the average, deeper than those wells located inland and water quality is poor, tends to support this theory.

3.4 Shingle Spit - Phipps Point

The Shingle Spit - Phipps Point area is bounded by steep topography of Mount Geoffrey to the east and the ocean to the west. Although a considerable number of wells are located between Shingle Spit and Phipps Point, well density is not as great as evident in other "small lot" areas of Hornby Island. Wells are located both along the coastline on small lots and inland on 10 acre size lots.

Considerable spring activity is apparent inland near the base of Mount Geoffrey. Much of this area downslope of Mount Geoffrey is characterized as natural "wetland". Surface water runoff from Mt. Geoffrey is likely significant, recharging the wetlands immediately downslope. The wetland in turn likely provides recharge to the underlying bedrock and wells downslope (Figure 14). The Groundwater Section has records of approximately 30 wells located on small lots. The average depth of drilled wells is 93 feet (28.3 metres). The deepest well on file is 340 feet (103.6 metres). Some well yields reported are very productive, giving evidence to the value of the wetlands in providing recharge to the underlying bedrock. The median reported well yield has been determined as 5 gallons per minute (0.31) litres per second). Residents responding to the 1992 *Islands Trust* groundwater questionnaire have indicated that water quantity and quality are generally excellent.

3.5 Fresh Water / Salt Water Interface Discussion

Chloride concentrations exceeding 100 mg/L have been reported in numerous wells located near and within the Sandpiper Subdivision

(Chwojka, 1989; 1984 ; Kohut et al, 1986). Many residents have reported "salty" water in their water supplies (Chwojka, 1989; 1984; 1992 *Islands Trust* questionnaire).

Salt water encroachment, by landward intrusion of salt water or up-coning of salt water beneath pumping wells, into the fresh water bedrock aquifer system is also a major concern for residents located within the low-lying coastal subdivisions of Hornby Island (Figure 15). As fresh groundwater flow towards the ocean is decreased due to increased pumping for example, salt water flow may be directed inward from the ocean. The degree of salt water movement inland is dependent on many factors including the time of year, local hydrogeology, well construction, pumping rates, and density and spacing between wells.

During the late summer / early fall, when groundwater demand is greatest and water levels are low, the fresh water / salt water interface would be expected to move furthest inland. In contrast, in the winter months when most precipitation and recharge to the groundwater system occurs, increased groundwater flow towards the ocean would force the interface to move towards the ocean.

If the local bedrock is fractured and porous and many wells completed below sea level are pumped, up-coning of salt water may occur. The depth of the fresh water / salt water interface is governed, among other factors, by the density difference between fresh and salt water. Theoretically, for every foot (or metre) the water table is above sea level, the boundary separating the fresh groundwater and salt water is about 40 to 45 feet (40 to 45 metres) below sea level (Figure 14). When the water table is lowered (by well pumping for example), for every foot (or metre) the water table is lowered, the interface rises 40 to 45 feet (40 to 45 metres). This up-coning of salt water may eventually reach the pumping well if pumping drawdown in the well is excessive (Figure 15). Fresh water / salt water interface contours have been shown in Figure 16. Contours are <u>interpretative</u> and <u>preliminary.</u> Fresh water / salt water contours are inferred from recorded historic water levels and ground elevations and the fresh water / salt water interface relationship (1 : 40 to 45). The boundary between fresh and salt water may, however, in reality be a diffused layer of mixed water and not the distinct boundary assumed in Figure 15. Structural discordances such as major faults and folding of the strata may influence the position of the interface. The contours as shown do, however, provide a preliminary approximation of the fresh water / salt water interface position. Future water level and water quality data will help to more clearly define the position and characteristics of the fresh water / salt water interface in the low-lying coastal areas on Hornby Island.

4. Abandoned / Unused Domestic Wells

Forty abandoned or unused wells were reported by Hornby Island residents participating in the 1992 *Islands Trust* groundwater questionnaire (Figure 17). Of the 40 wells, 15 wells were drilled and 25 wells were dug. The questionnaire has revealed a potentially serious situation previously unknown, as well drilling contractors and property owners are not required by legislation to report the existence of abandoned wells. Aside from the safety hazard posed to humans by uncovered large diameter wells, the most immediate threat from abandoned wells is that of groundwater contamination. If the abandoned well is not properly sealed, contaminated surface water or other contaminants can enter the well and contaminate the groundwater.

However, where unused wells are adequately constructed and strategically located, they could serve a useful purpose as observation wells located in areas of Hornby Island where groundwater monitoring is required.

In July, 1993 a number of the abandoned or unused wells noted on the *Islands Trust* questionnaire were investigated and two of these wells were established as long-term observation wells. These wells are located within the Whaling Station Bay area and southwest of the Galleon Beach Subdivision and are equipped with locking well caps and will be monitored once per month by local observers. Water level data will be collected to study aquifer response to groundwater recharge and withdrawal and will assist in making decisions concerning the future land and water use planning on Hornby Island.

5. Establishment of Community Wells Inland

As recommended by Chwojka (1984), establishment of community wells on Hornby Island should be considered. Water quality problems are evident in wells located on existing small lot subdivisions. Establishment of community wells may help alleviate these problems. As a preliminary step, areas inland where high capacity wells are reported should be investigated (thirty wells on Hornby Island have reported yields of 20 gallons per minute (1.5 litres per second) or greater). Test drilling would be required to assess the potential of an area, the groundwater quality, and the effects groundwater withdrawal would have on existing nearby wells. Economic factors such as well construction and testing costs and pipeline and system hook-up costs would have to be taken into consideration.

The subject Crown Land may not need to be considered for establishment of community wells as there are areas inland with road and power access upslope of all major small lot subdivisions that may have potential sites for construction of community wells.

6. Conclusions

1. The subject Crown Land can be characterized as having thin soil cover and moderately to steeply sloping topography. Although surface water runoff is probably significant, recharge to the underlying bedrock aquifer system does occur when heavy rainfall forms intermittent streams and wetlands that eventually infiltrate into the bedrock. The subject Crown Land is located in the uplands and, although negligible groundwater data exist within the upland areas, groundwater levels in the surrounding lowland areas and topographic considerations, suggest the upland areas, including a significant part of the subject Crown Land are an important natural groundwater storage and catchment area providing recharge to wells located within the surrounding lowlands of Hornby Island. The precise recharge area can not, however, be determined without more groundwater data. The recharge boundaries inferred from areas of deeper depth to water and vegetation suggest a significant portion of the subject Crown Land lies in a recharge area. Parts of the subject Crown Land in lower elevation areas may be local discharge areas, however these areas likely provide recharge for areas further down gradient.

2. A preliminary assessment has shown that the upland recharge area including the Subject Crown Land is likely vulnerable to groundwater contamination. Existing hydrogeological information suggests that if a contaminant were introduced in the upland, local hydrogeologic conditions would likely result in this contaminant infiltrating into the bedrock aquifer and travelling down gradient towards the lowlands. A comprehensive examination is however necessary to more fully understand specific contaminant transport.

3. The majority of existing water quality concerns on the island exist within small lot subdivisions. All subdivisions except around Whaling Station Bay peninsula are likely recharged by the Mount Geoffrey upland area. Well location, high well density, close spacing between wells, thin soil cover, and improperly located or improperly designed sewage disposal systems may all contribute to the occurrence of poor and non-potable groundwater. Major water quality concerns on Hornby Island are sewage effluent contamination of wells, hydrogen sulphide gas, high iron, and salt water encroachment. The 1992 *Islands Trust* groundwater questionnaire has been very useful and supportive in updating our present knowledge of the types of water quality problems and where water quality problems exist. The *Islands Trust* questionnaire has also indicated where areas exist that may have excellent potential having minimal water quality problems.

4. The Groundwater Section has 512 records of wells recorded on Hornby Island. Eighty-six percent of wells are drilled while the remaining fourteen percent are dug. Sixty-six percent of all wells are located on lots generally of 1/2 acre (0.20 hectare) size or smaller and are located within the subdivisions of Sandpiper, Galleon Beach, Whaling Station Bay and the Shingle Spit-Phipps Point area. As submission of well records by drilling contractors is not compulsory, many more "unreported" wells may exist on Hornby Island. Only 2 wells are located within the subject Crown Land.

5. The average depth of water wells on Hornby Island is 138 feet (42.1 metres) and the deepest water well on record is 500 feet (152.4 metres) located at Sandpiper Subdivision. The majority of wells are completed in bedrock, however, some successful wells have been completed within alluvial deposits near the mouth of

Beulah and Ford Creeks.

6. The median reported well yield for all wells is 4 gallons per minute (0.25 litres per second). The greatest reported well yield on Hornby Island is 50 gallons per minute (3.1 litres per second). Reported well yields are however based on simple bail tests and not from long-term pumping tests.

7. Data collected from Observation Well No. 288 suggests recharge to the bedrock aquifer system is derived from precipitation falling directly on Hornby Island. Data also show that long-term aquifer depletion is not occurring; however, water level response at this site reflects regional groundwater conditions rather than local groundwater conditions.

8. The 1992 *Islands Trust* Groundwater Questionnaire has indicated that at least 40 dug and drilled abandoned or unused wells are located on Hornby Island. These unused wells may pose a physical hazard and also provide a direct pathway for any contaminants to the aquifer. Some of these unused wells which are suitably constructed and strategically located could be useful as observation wells. The remaining unused wells should be properly decommissioned.

In July, 1993 a number of unused/abandoned domestic wells were investigated and two drilled wells were established as long-term observation wells. These wells are located within the Whaling Station Bay area and southwest of the Galleon Beach Subdivision. Water levels will be monitored on a once per month basis by local observers. Collection and analysis of water level data will assist in making decisions concerning the future land and water use planning on Hornby Island.

7. Recommendations

1. The subject Crown Land should be protected as a community watershed area to ensure preservation of the quantity and quality of groundwater on Hornby Island. Any activities or proposed land use in the subject Crown Land should be reviewed as to possible impacts on the underlying groundwater resource. Groundwater and land use policies should be developed to protect the groundwater resource in the subject Crown Land area. A preliminary list of activities which should be subject to restriction in this area is provided in Table 3

2. Springs and discharge features should be mapped in more detail to delineate more precisely the recharge areas of Hornby Island on a regional scale. Locating springs should be conducted at a time of maximum or near maximum recharge (December to March).

3. A water quality reconnaissance study is recommended for the late summer when groundwater demand is highest and water levels are lowest. Field analysis with selected lab analysis would be sufficient and resident participation should be encouraged. Wells located within the small lot subdivisions should be targeted for sampling. Field analyses should include bacteriological tests, and determination of total dissolved solids and salinity which would be helpful in determining the position of the fresh water / salt water interface.

4. Drilling of observation wells is recommended to obtain direct groundwater information in the upland areas where data are lacking .

5. An up-to-date water well record collection program should be undertaken to obtain well information and further understand groundwater conditions on Hornby Island.

6. Pump testing of selected wells is recommended to determine permeability of the bedrock aquifer for estimating flow rates on Hornby Island.

7. The existing network of observation wells should be expanded and a network of water quality sites set up to monitor long-term groundwater level and quality trends on Hornby Island.

8. Information on land use on Hornby Island should be obtained to help interpret groundwater data and further determine sensitive groundwater areas. Local residents can greatly assist in this task.

9. Groundwater data for groundwater mapping and modelling should be compiled and interpreted to quantify the groundwater flow system on Hornby Island. Increased understanding and delineation of the groundwater resource will lead to better management of the resource.

10. Consideration should be given to establishment of community water wells in areas inland and upslope of the small lot subdivisions. The subject Crown Land may not need to be considered for establishment of community wells.

11. Abandoned wells should be investigated and well owners should be informed on the importance of having abandoned wells properly decommissioned and methods of safe closure.

8. Acknowledgements

The author would like to give special acknowledgement to Carol Martin and Catherine Howard for coordinating and carrying out the groundwater questionnaire survey. Special thanks also go to Bill McInnes for contribution of his drafting skills and Joe Nemeth and David Kilshaw, Resource Inventory Section, Inventory Branch, Ministry of Forests for their assistance in identifying and interpreting vegetation on Hornby Island.

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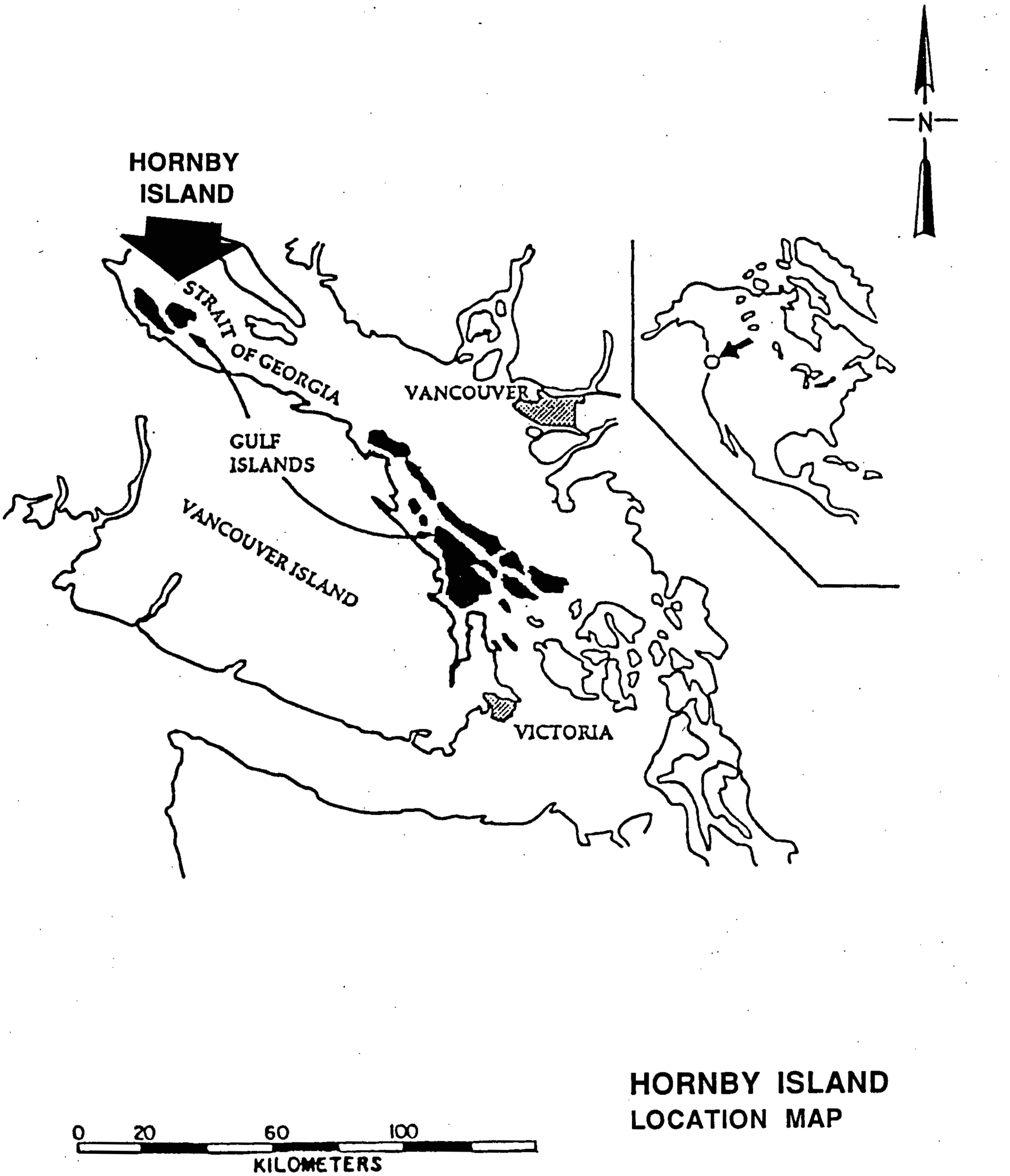
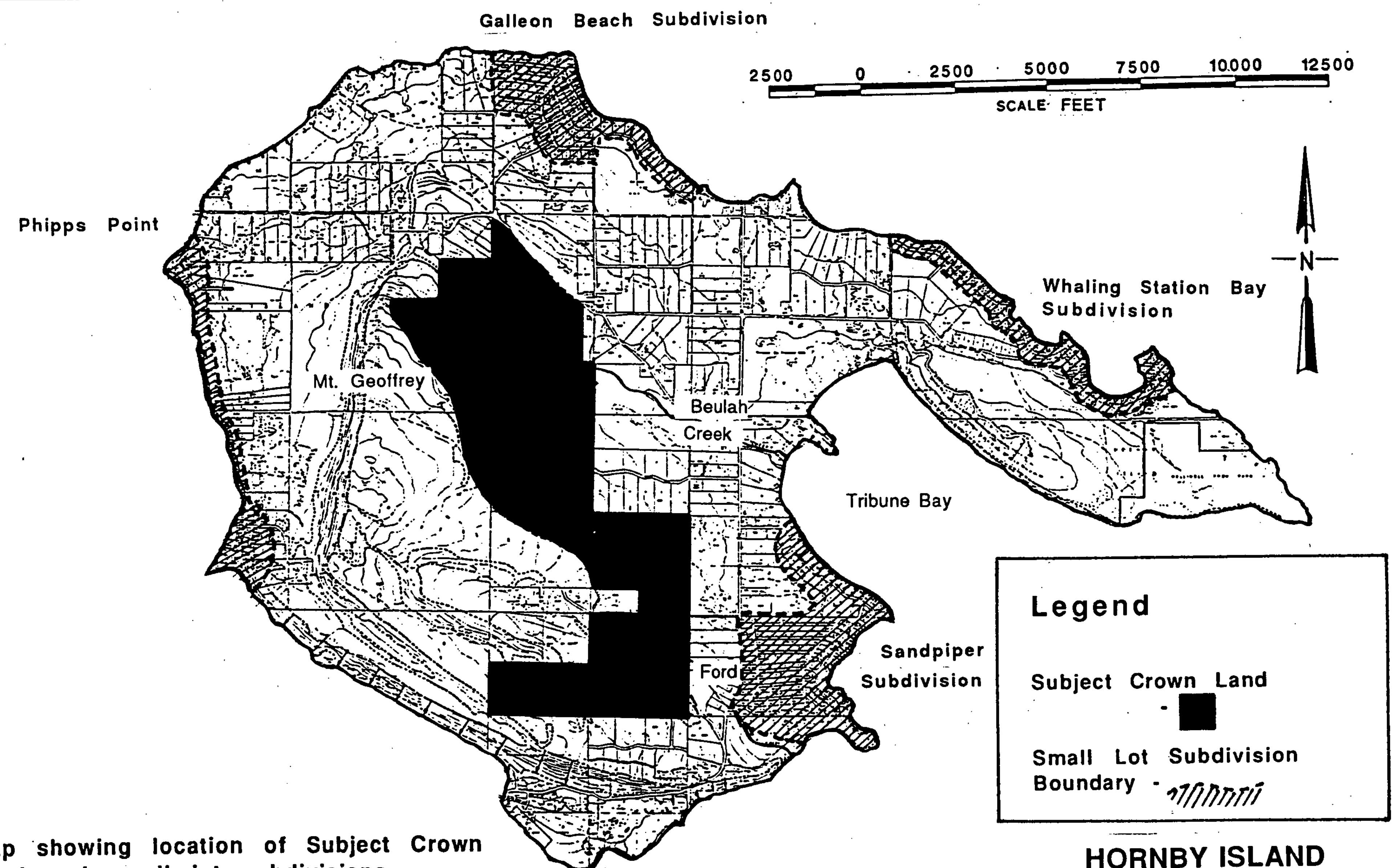


HORNBY ISLAND
LOCATION MAP

(Adapted from Groundwater Resources of British Columbia, 1993)

Province of British Columbia Ministry of Environment WATER MANAGEMENT BRANCH	TO ACCOMPANY REPORT ON A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993
SCALE: As Shown — DATE April 1993	ENGINEER FILE No. DWG No. Figure 1

VAN CAL 15712

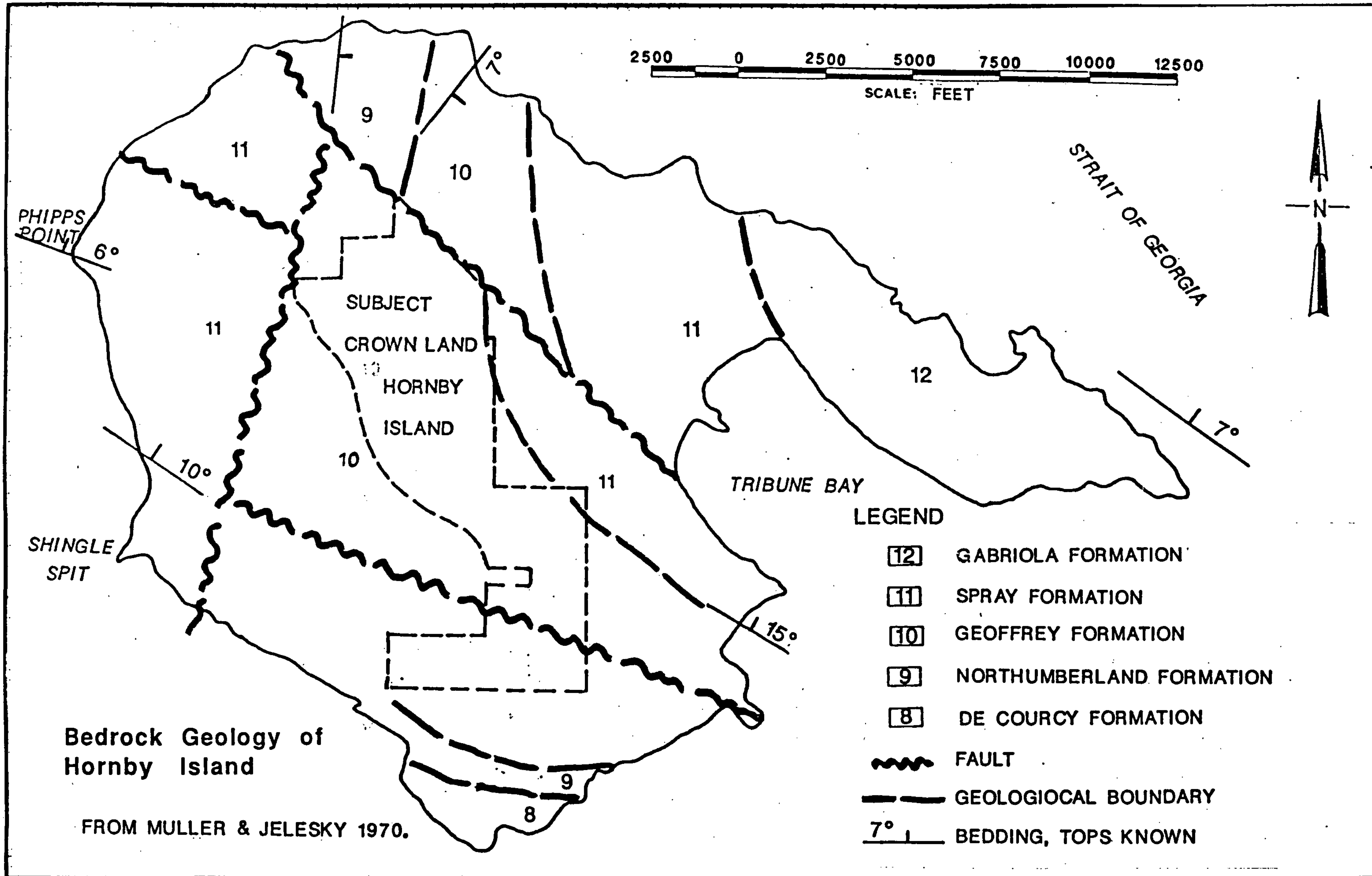


Map showing location of Subject Crown Land and small lot subdivisions

HORNBY ISLAND

Province of British Columbia Ministry of Environment INVENTORY AND ENGINEERING BRANCH	TO ACCOMPANY REPORT ON A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993	SCALE: AS SHOWN ENGINEER FILE No. DWG. No. Figure 2	DATE Jan. 1993

VANCAL – 7189



Province of British Columbia
Ministry of Environment, Lands and Parks
WATER MANAGEMENT DIVISION

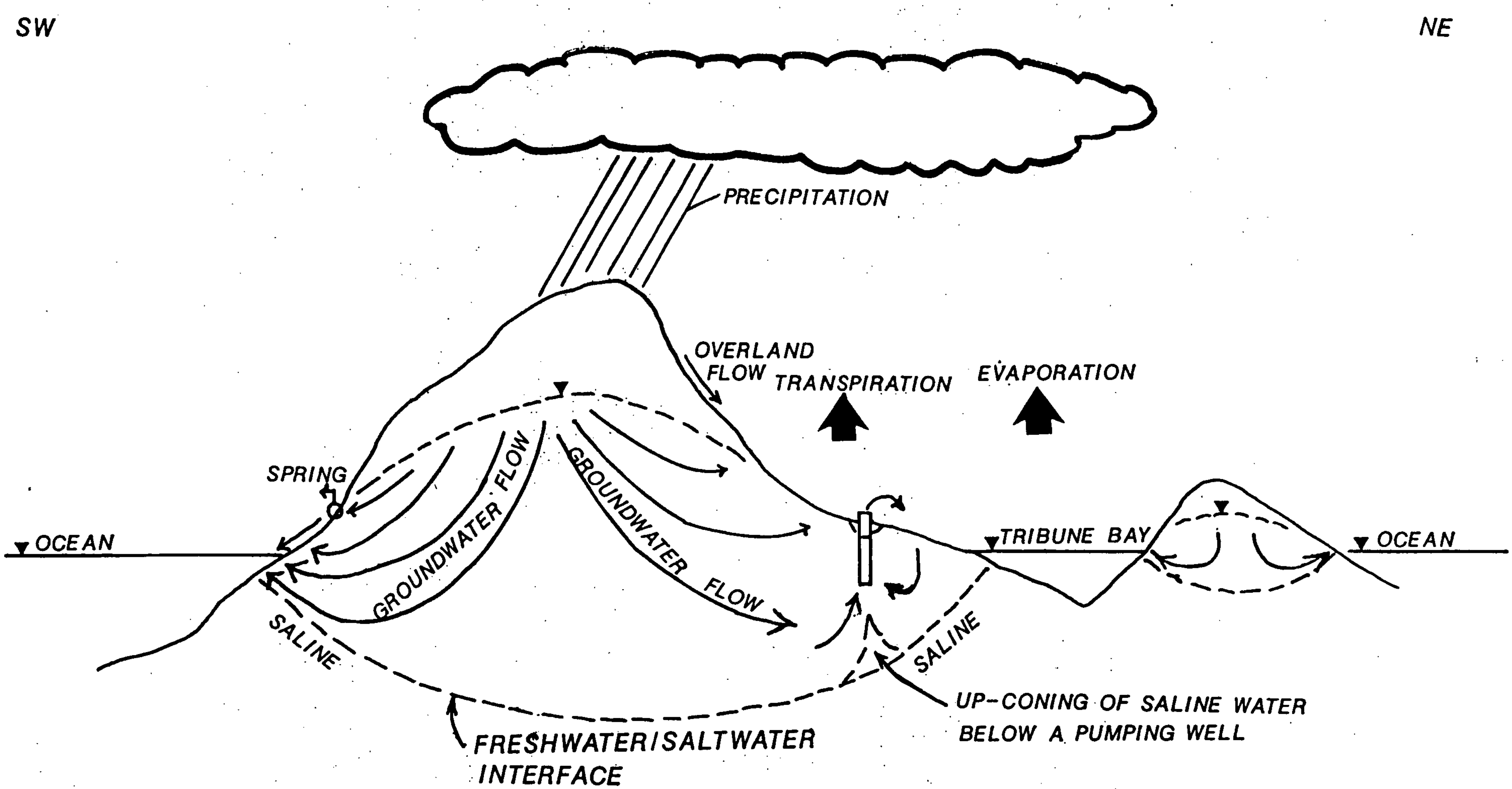
TO ACCOMPANY REPORT ON
A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993

SCALE: AS SHOWN

DATE: APRIL 1993

ENGINEER

FILE No. DWG. No. Figure 3



HORNBY ISLAND (SCHEMATIC OF HYDROLOGIC CYCLE)

Province of British Columbia Ministry of Environment and Parks WATER MANAGEMENT BRANCH	TO ACCOMPANY REPORT ON A GROUNDWATER ASSESSMENT OF A CROWN LAND PARCEL ON HORNBY ISLAND–1993	SCALE: N.T.S.	DATE MARCH 1993
		FILE No.	DWG. No. Figure 4

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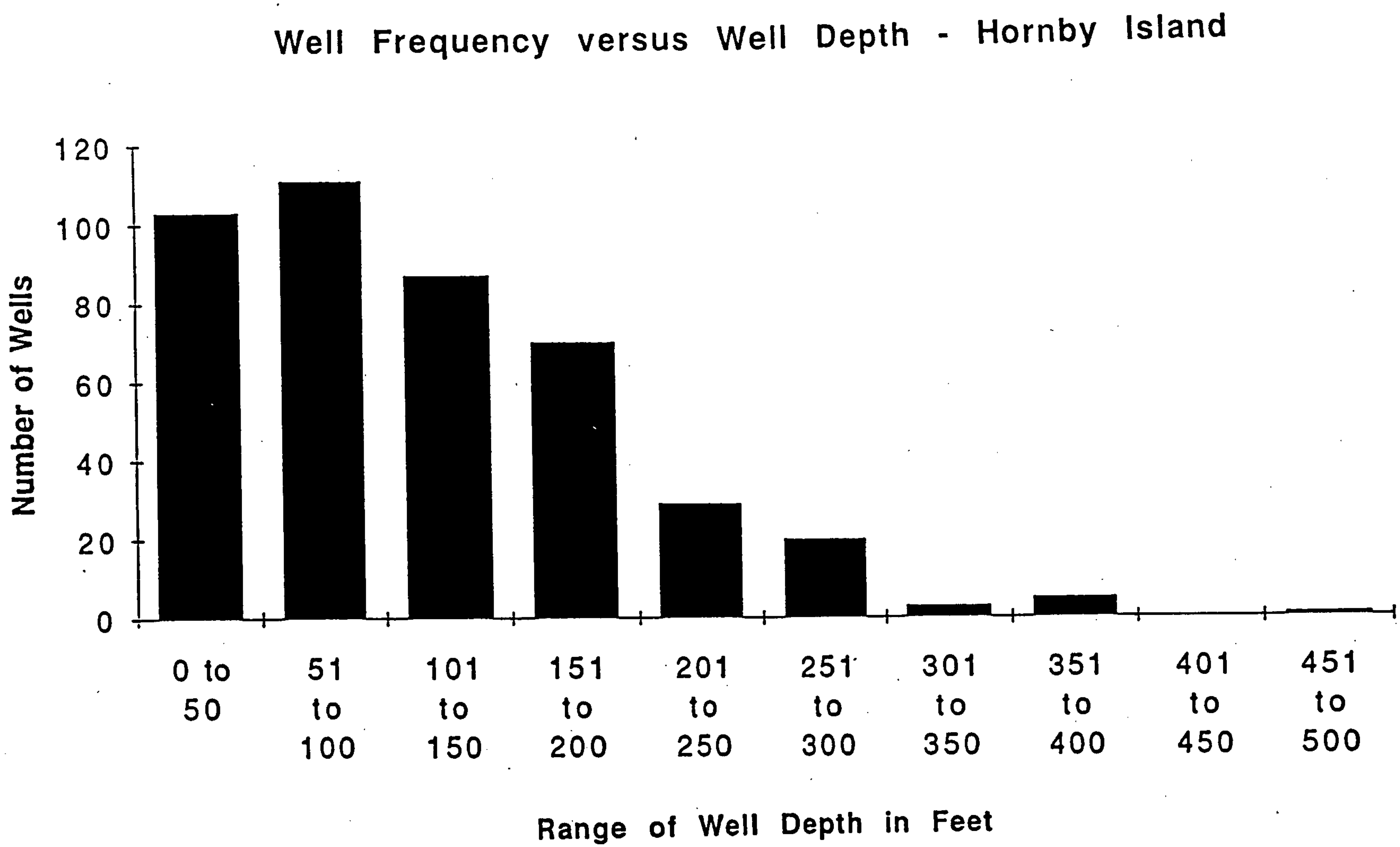
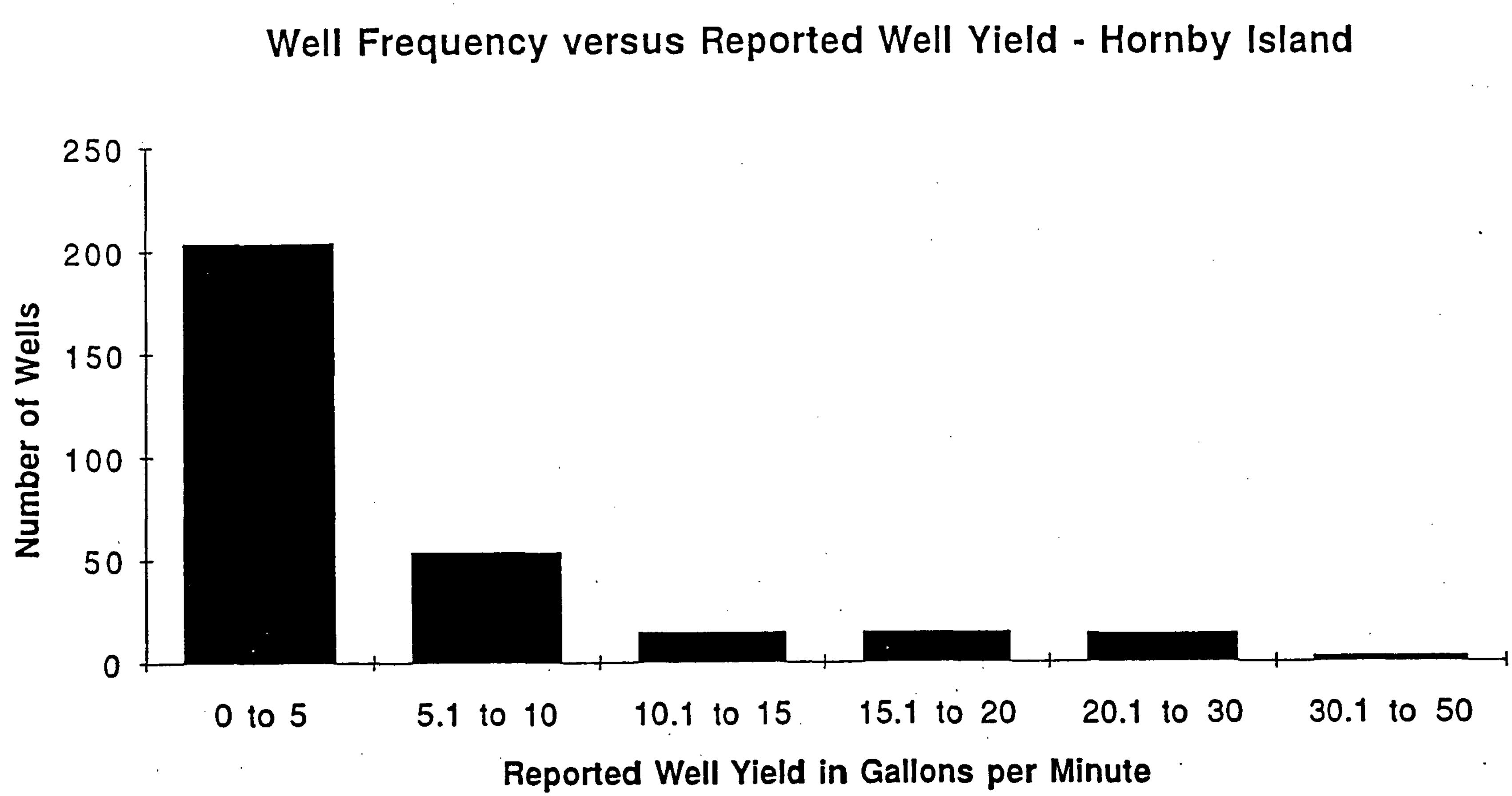


Well Frequency versus Well Depth - Hornby Island
Number of Wells
120
100
80
60
40
20
0
0 to 50
51 to 100
101 to 150
151 to 200
201 to 250
251 to 300
301 to 350
351 to 400
401 to 450
451 to 500
Range of Well Depth in Feet

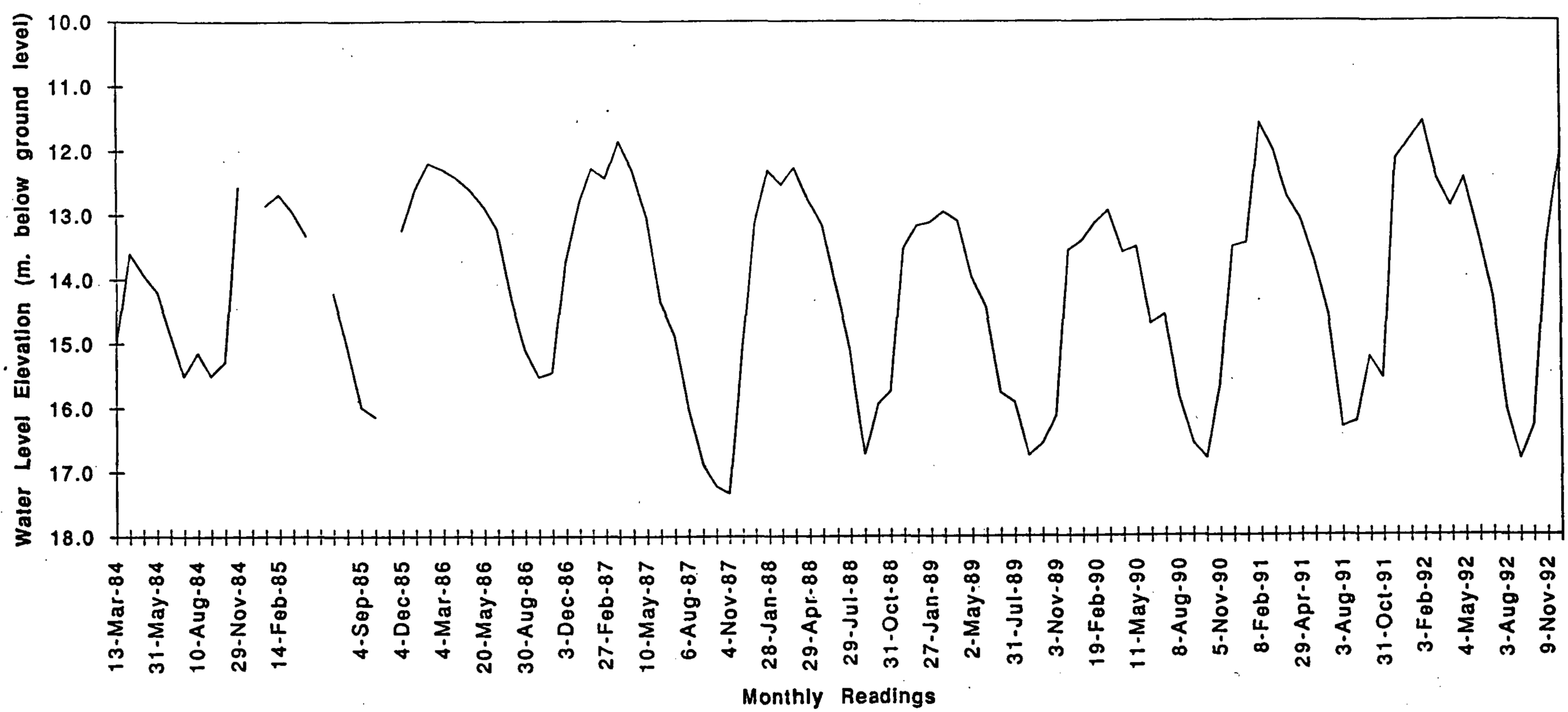
Figure 6



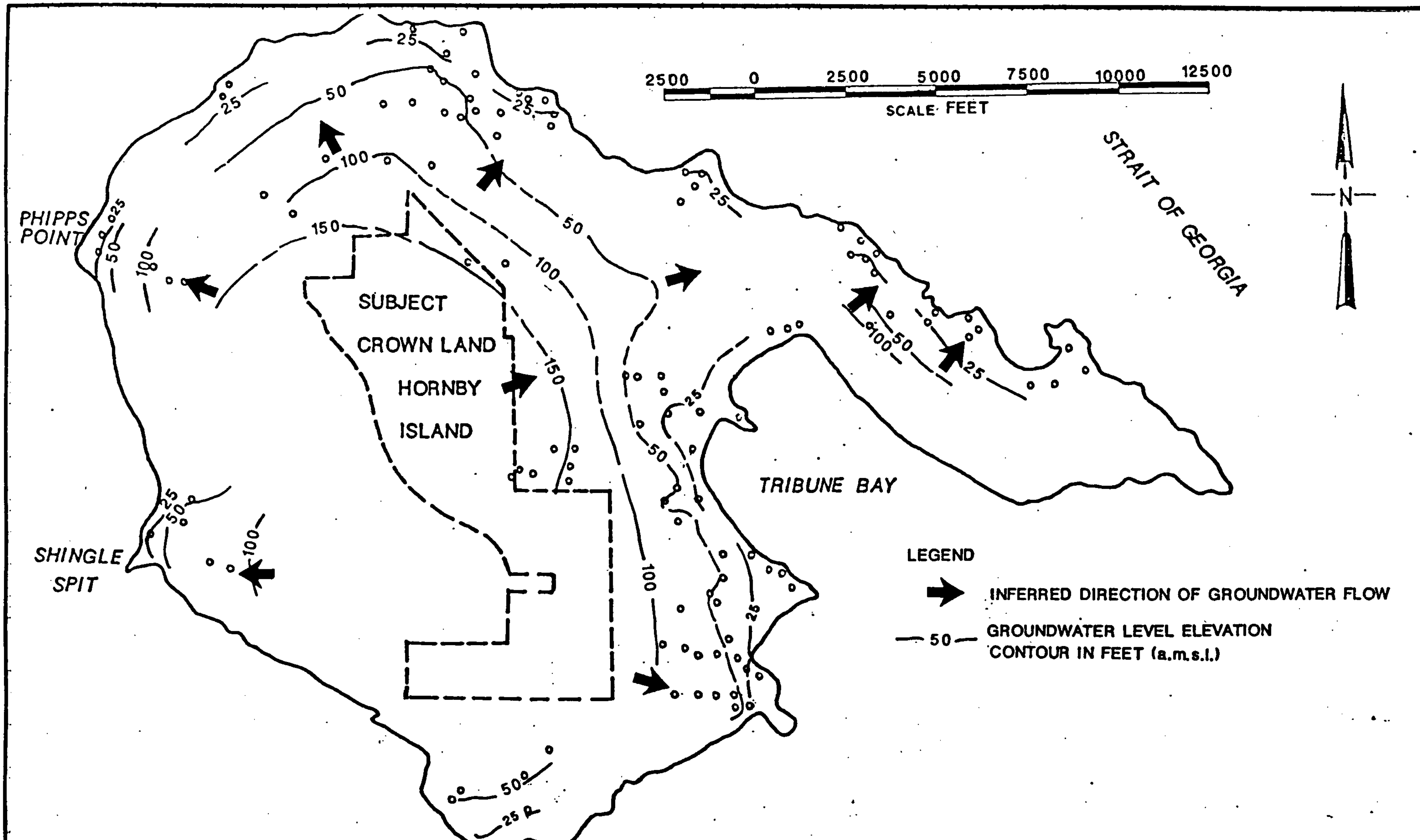
Well Frequency versus Reported Well Yield - Hornby Island
250
200
150
100
50
0
Number of Wells
0 to 5
5.1 to 10
10.1 to 15
15.1 to 20
20.1 to 30
30.1 to 50
Reported Well Yield in Gallons per Minute

Figure 7

Month-End Hydrograph for Observation Well No. 288 - Hornby Island



Province of British Columbia Ministry of Environment and Parks WATER MANAGEMENT BRANCH	TO ACCOMPANY REPORT ON A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993	SCALE: As Shown DATE: April 1993 ENGINEER FILE No. DWG. No. Figure 8



Regional Groundwater Level Elevation Contour Map

Province of British Columbia Ministry of Environment, Lands and Parks WATER MANAGEMENT DIVISION	TO ACCOMPANY REPORT ON A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993	SCALE: AS SHOWN ENGINEER FILE No. DWG. No. Figure 9	DATE APRIL 1993

Groundwater Level versus Ground Elevation - Hornby Island

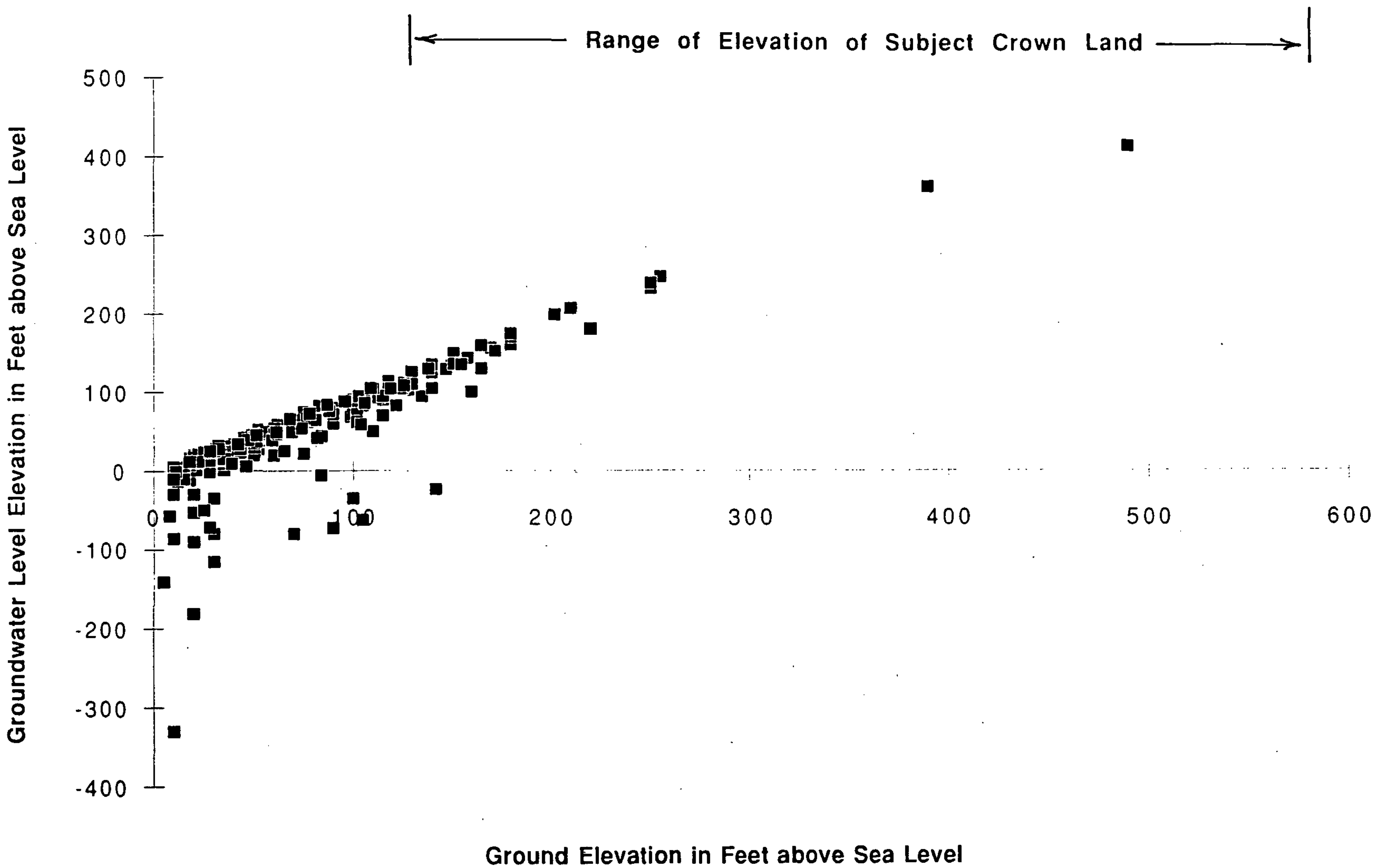
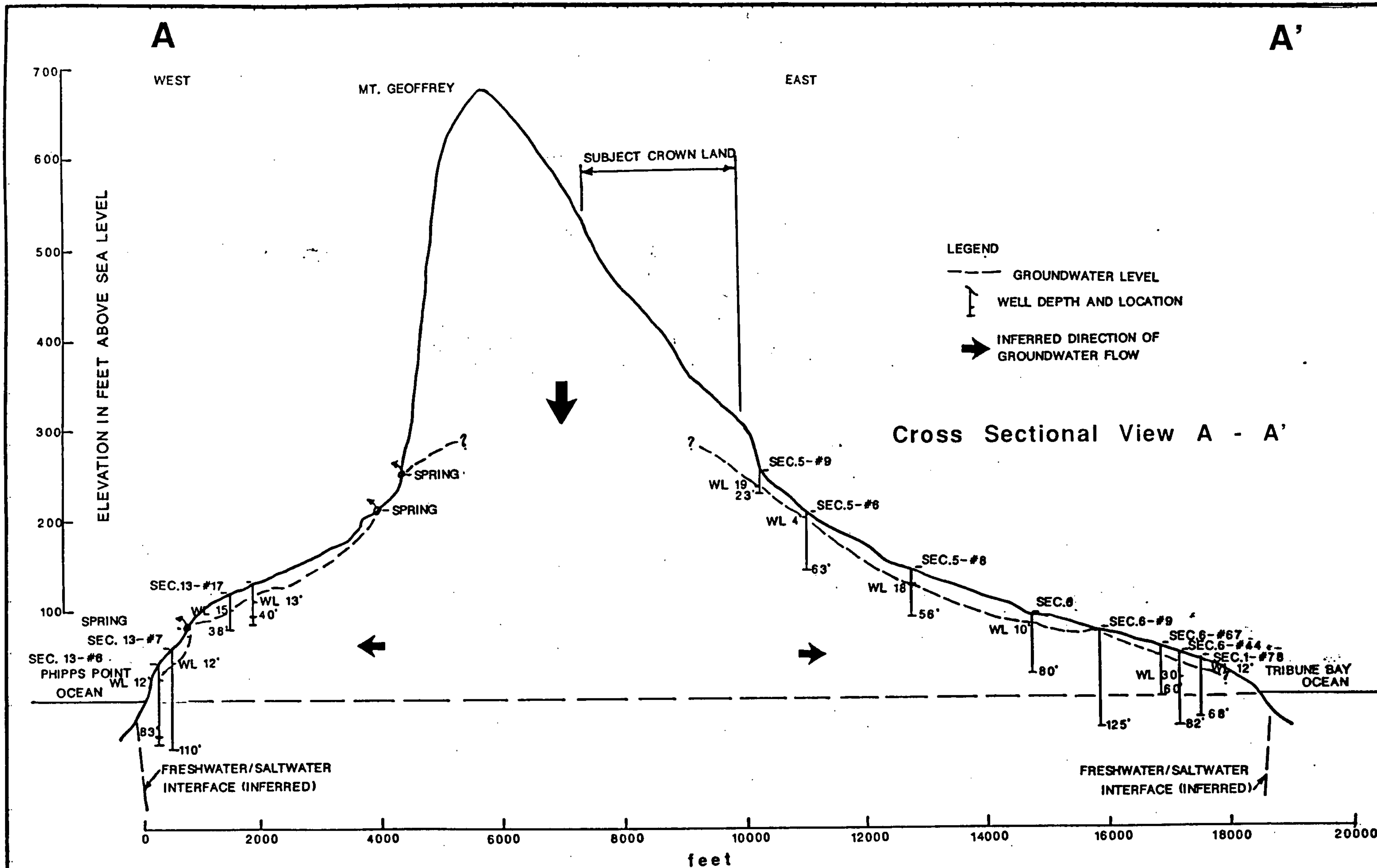


Figure 10



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A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993

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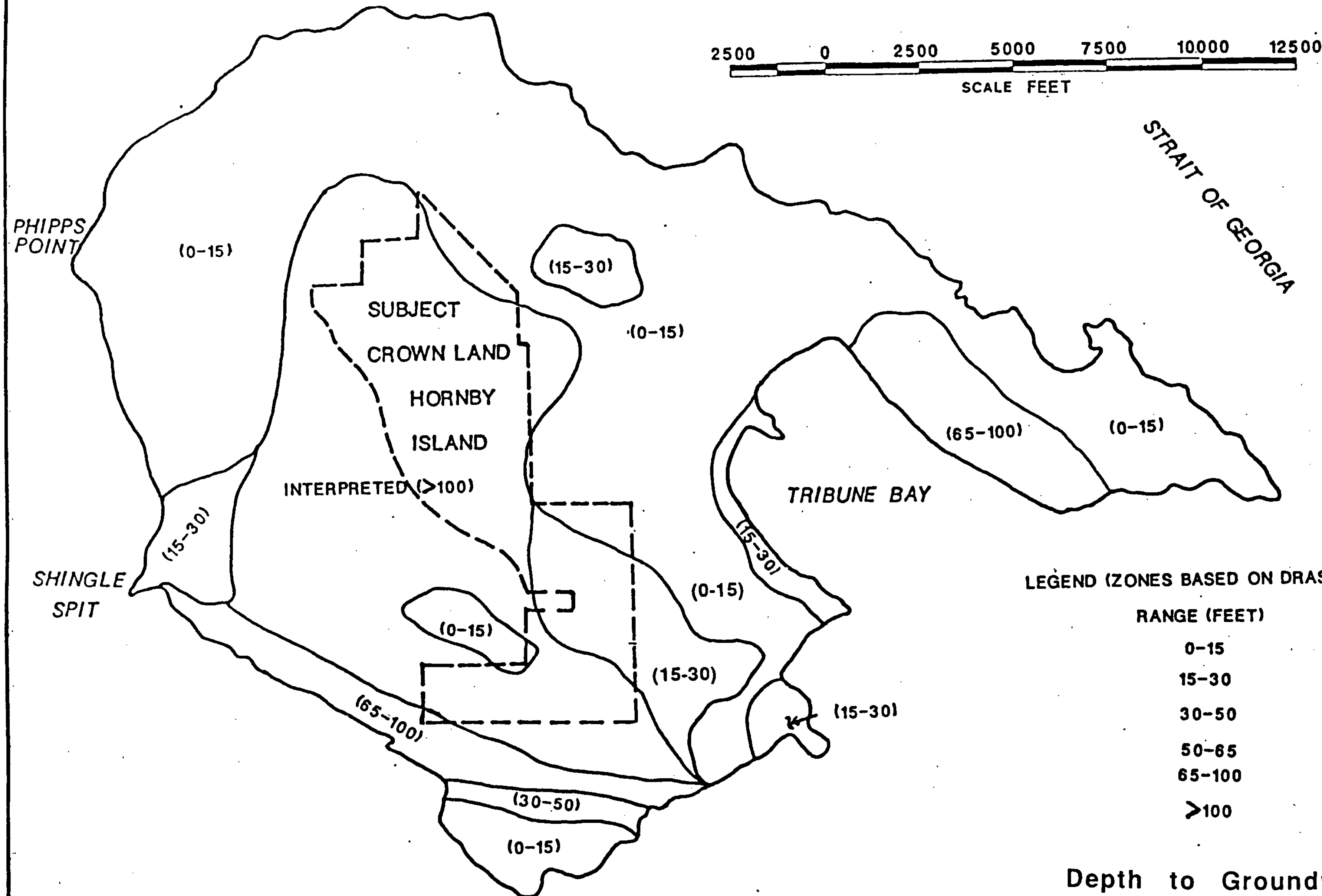
ENGINEER

FILE No. DWG. No. Figure 11



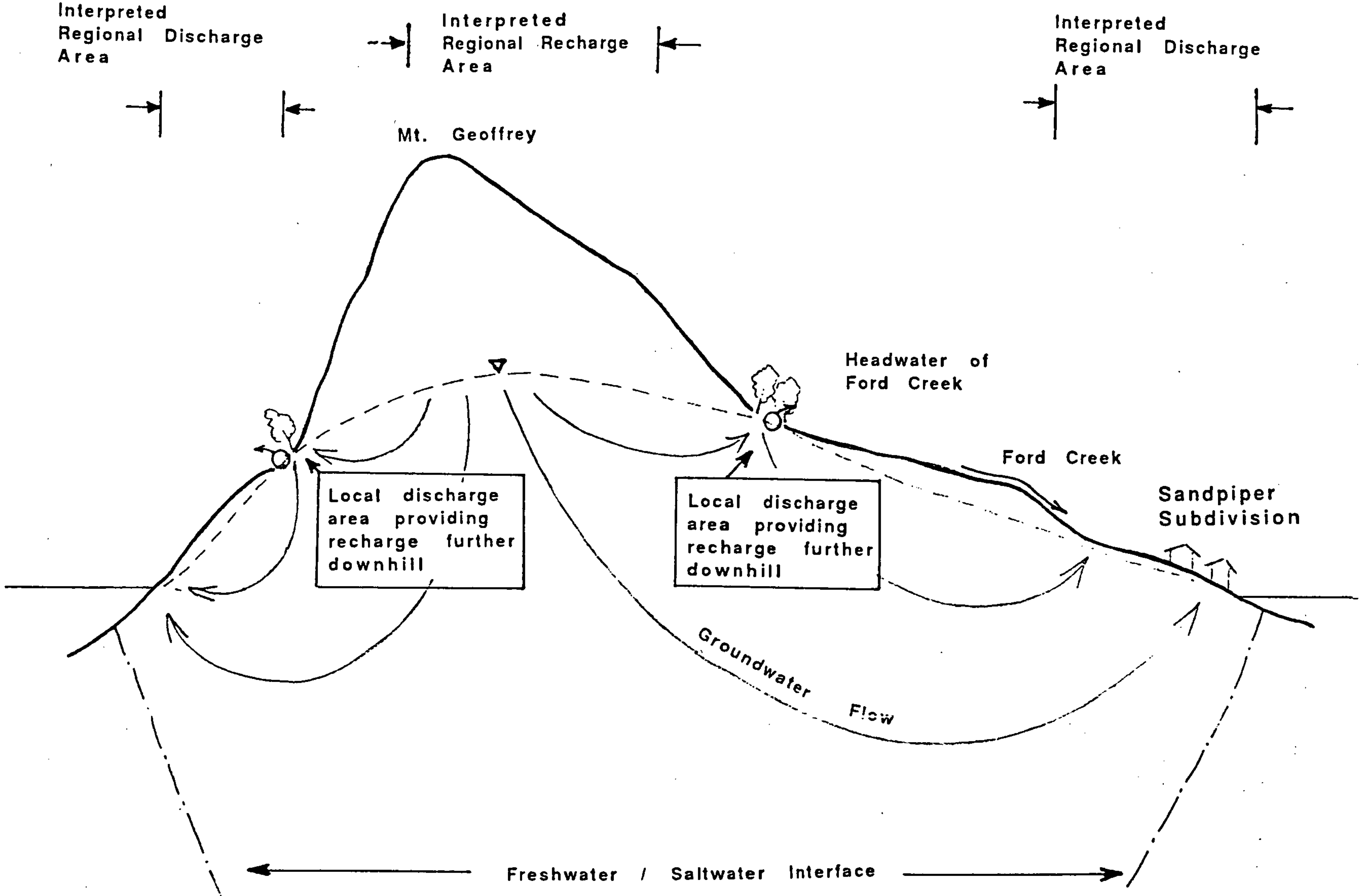
LEGEND (ZONES BASED ON DRASTIC)

RANGE (FEET)

0-15
15-30
30-50
50-65
65-100
>100

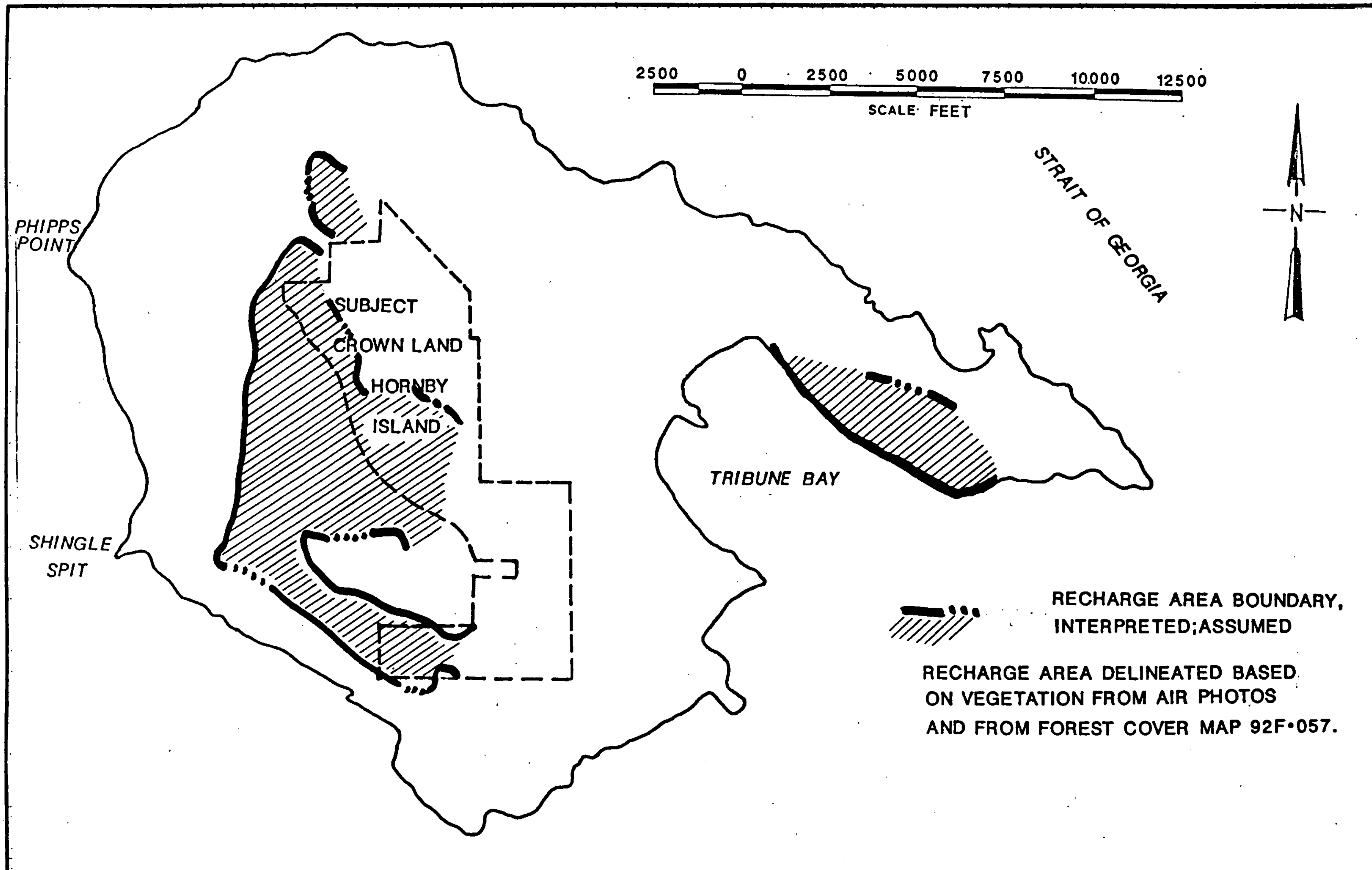
Depth to Groundwater

Province of British Columbia Ministry of Environment, Lands and Parks WATER MANAGEMENT DIVISION	TO ACCOMPANY REPORT ON A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993	SCALE: AS SHOWN ENGINEER FILE No. DWG. No. Figure 12	DATE APRIL 1993



Relationship between Regional and Local Recharge/ Discharge Areas

Province of British Columbia Ministry of Environment, Lands and Parks WATER MANAGEMENT DIVISION	TO ACCOMPANY REPORT ON A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993	SCALE: N.T.S ENGINEER FILE No. DWG. No. Figure 13	DATE APRIL 1993



Province of British Columbia
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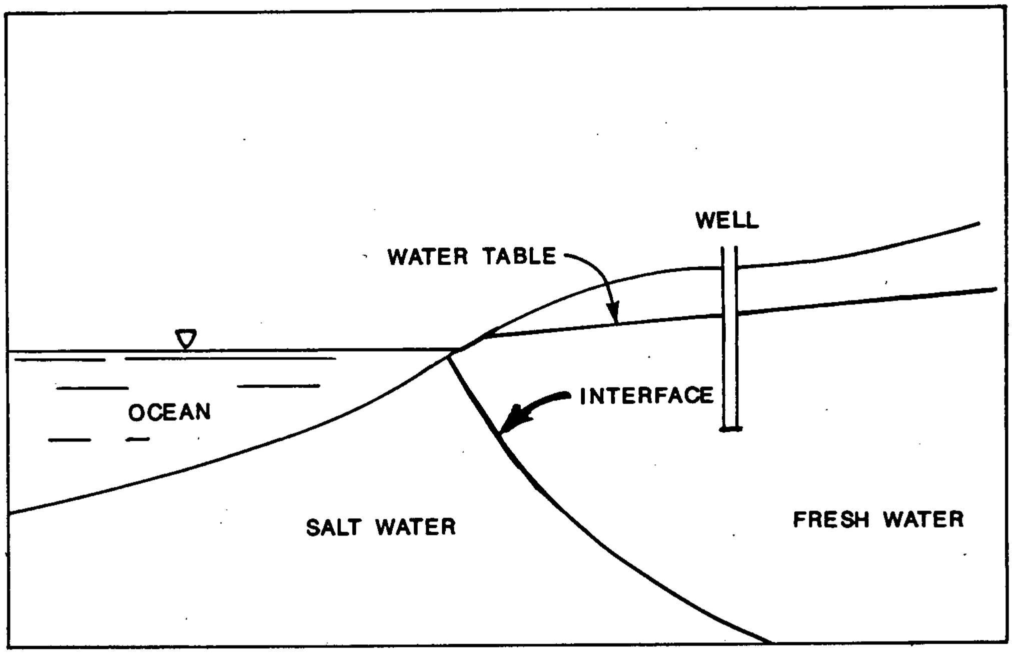
WATER MANAGEMENT DIVISION

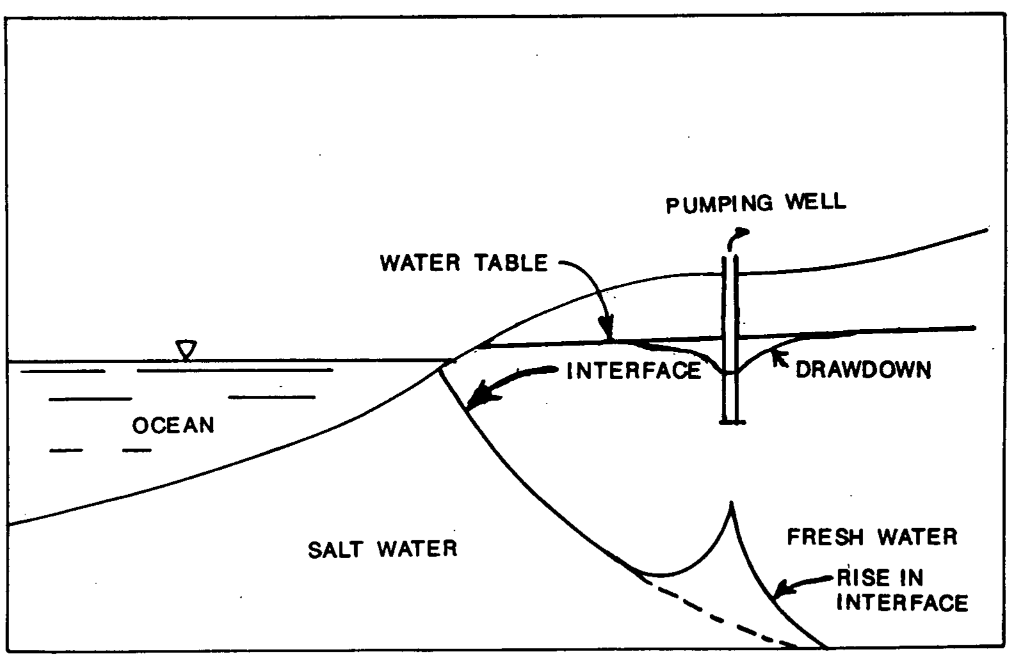
TO ACCOMPANY REPORT ON
A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993

SCALE: AS SHOWN
DATE: APRIL 1993
M. WEI — ENGINEER
FILE No. DWG. No. Figure 14

Fresh water / Salt water Interface Relationship - Hornby Island

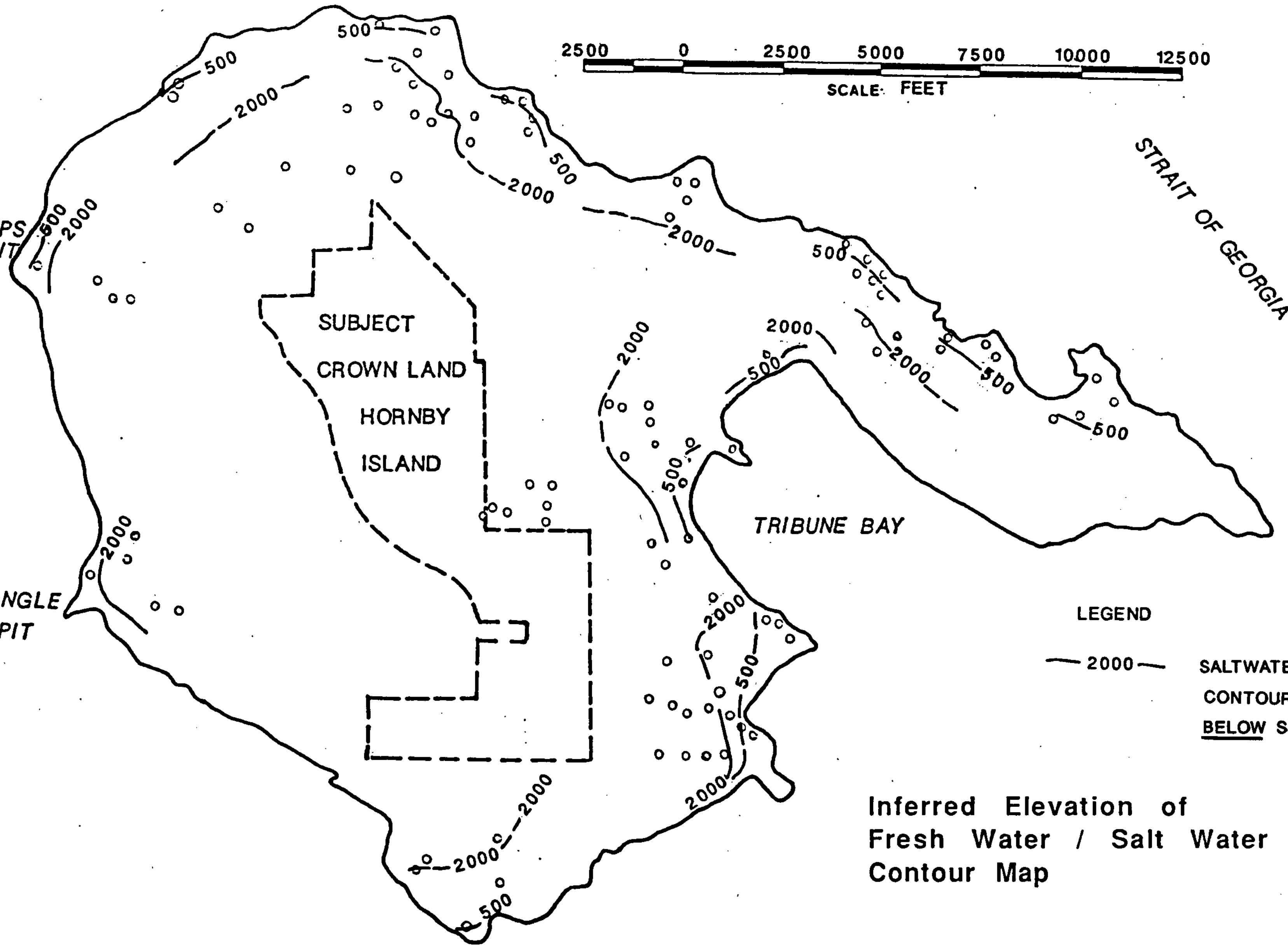


During non-pumping conditions, for every foot (metre) the water table is above sea level, the freshwater/saltwater interface is 40-45 feet (40-45 metres) below sea level.



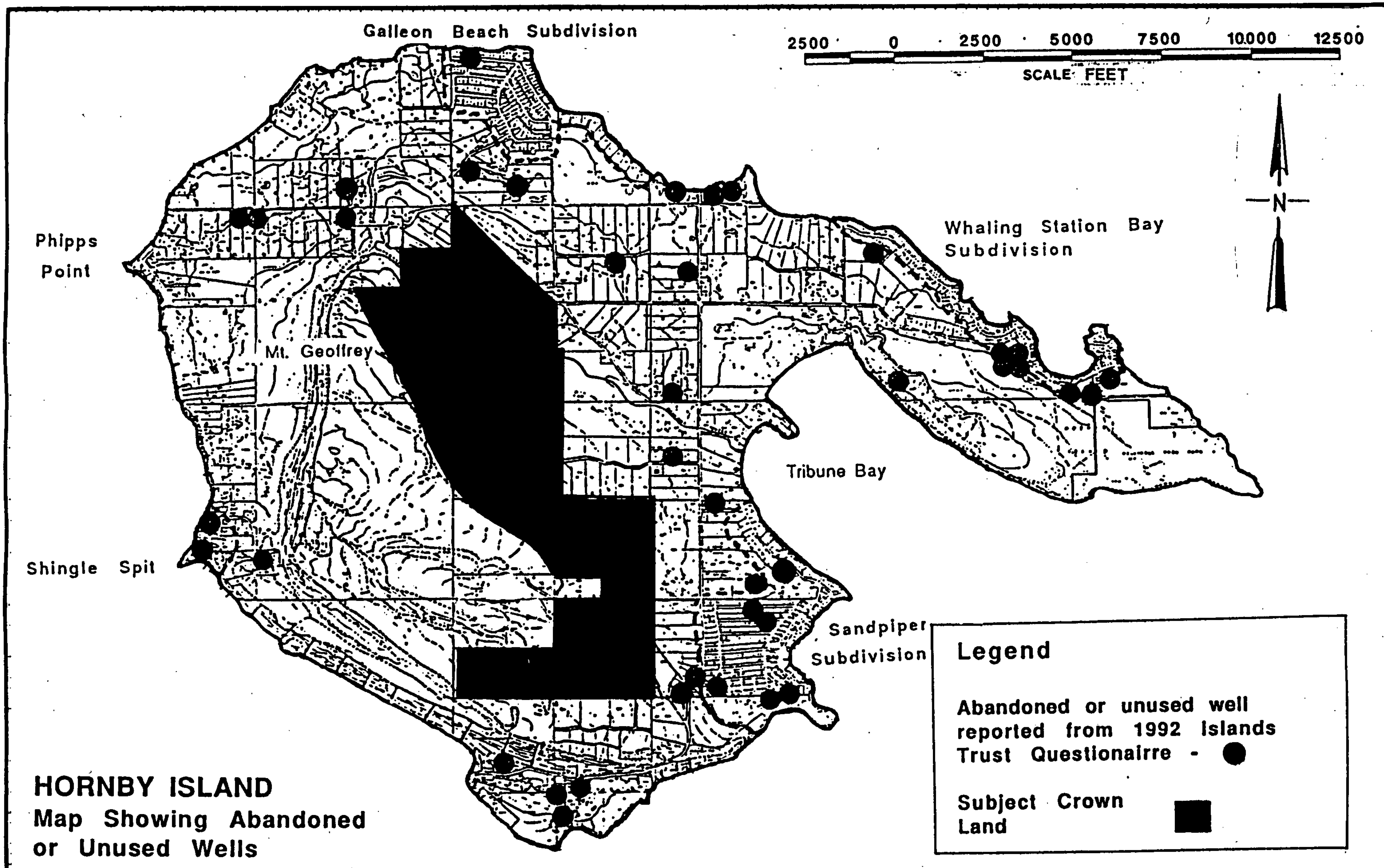
During pumping conditions, for every foot (metre) of drawdown of the water table, the freshwater/saltwater interface rises 40-45 feet (40-45 metres).

Figure 15



Inferred Elevation of Fresh Water / Salt Water Interface Contour Map

Province of British Columbia Ministry of Environment, Lands and Parks WATER MANAGEMENT DIVISION	TO ACCOMPANY REPORT ON A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993	SCALE: AS SHOWN ENGINEER FILE No. DWG. No.	DATE APRIL 1993 Figure 16



HORNBY ISLAND
Map Showing Abandoned or Unused Wells

Province of British Columbia Ministry of Environment, Lands and Parks WATER MANAGEMENT DIVISION	TO ACCOMPANY REPORT ON A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993	SCALE: AS SHOWN DATE ENGINEER FILE No. DWG. No. Figure 17

Table 1 - Hornby Island Bedrock Formation Summary (based on Muller and Jeletzky, 1970)

BEDROCK FORMATION	PRINCIPAL LITHOLOGY	COMMENTS
GABRIOLA	medium-coarse grained massive sandstone with minor conglomerate lenses	The "Hornby" conglomerate of the Comox Basin contains sandstone, pebbly sandstone, and massive conglomerate The beds of St. John Point on Hornby Island are estimated to be 600 to 800 feet thick. Underlies Whaling Station Bay.
SPRAY	shale and resistant sandstone	Outcrops observed north of Shingle Spit, Hornby Island. Section at Tribune Bay is 950 feet thick. The name "Spray" applied to shales partly outcropping on and underlying Tribune Bay. Spray Point is a resistant sandstone ledge projecting into the middle of Tribune Bay.
GEOFFREY	coarse conglomerate with minor sandstone	In the Comox Basin, the Northumberland Formation is overlain by the Geoffrey Formation.
NORTHCUMBERLAND	Shale	In the Comox Basin, the Northumberland Formation outcrops on the northeast coast of Denman Island and the southwest coast of Hornby Island. Less than 200 feet is exposed on Hornby Island.
DE COURCEY	Brown-grey massive sandstone with shale layers	In the Comox Basin, the DeCourcy Formation occurs at Norman Point and at Norris rocks, Hornby Island.

Table 2 Small Lot Subdivision Well Record Summary - Hornby Island

Area	No. of Wells	Depth Range (feet)	Average Depth (feet)	Deepest Well (feet)	Range of Yield (gpm)*	Median Yield (gpm) *
Sandpiper	132	10 - 500	129	500	0.2 - 30	5 gpm
Galleon Beach	56	3 - 300	131	300	0.03 - 20	3 gpm
Whaling Station Bay	85	7 - 392	162	392	0 .07 - 20	2 gpm
Shingle Spit-Phipps Pt.	30	12 - 340	93	340	0.33 - 36	5 gpm

* Most reported yields are based on short term bail tests

Table 3	**Examples of Land Use Activities Subject to Restriction to Sustain Groundwater Quantity and Quality**
	Construction Excavation, quarrying, soil removal
	Burning
	Commercial, Industrial and Residential Development
	Extensive Logging
	Concentrated Animal Feeding Operations
	Intensive Farming and Fertilizer and Pesticide Application
	Hazardous and Non-Hazardous Waste Storage Tanks
	Materials Stockpiling and Storage
	Waste Disposal including landfills
	Open Dumps
	Cemetaries
	Golf Courses
	Extensive Road Development
	Ditching and Drainage Works
	Modification of Natural Drainage Features

Appendix A

Hornby Island Well Record Data

						HORNBY ISLAND - WELL RECORD DATA										
BCGS MAP	NO.	OLD NO.	LOT	PLAN	SEC.	WELL DEPTH (feet)	WAT. DEPTH (ft. bel. t.c)	LAND ELEV (ft.ab. s.l.)	W.T. ELEV. (ft.ab. s.l.)	BED DEPTH (ft. bel. g.l.)	YIELD	UNIT	CONST DATE	LAB CHEM	SITE ID	FIELD CHEM
092F047434	1	1			18		8	73	65					Y	1400728	
092F047434	2	2			18	18	12	10	2							
092F047434	3	2			2	10	32									
092F047434	4	3			2	9	4									
092F047434	5	3	A	93402D	18	10	7	41	34					Y	1400727	
092F047434	6	4			18	12	5	50	45							
092F047434	7	4	9		2	12	6	30	24							
092F047434	8	5	A	12947	2	10	4	49	45							
092F047434	9	6	A	28649	2	250				4			770101			
092F047434	10	7				110	40	220	180	45	1	GPM	770901			
092F047434	11	8	9	8602	2	193				6			760603			
092F047434	12	9	9	8602	2	150	20	45	25	13			760204			
092F047434	13	10	9	31622	2	250				4			800612			
092F047434	14	11	B	31622	2	156				2			800101			
092F047434	15	12	8	29474	2	228	79	490	411	4	7	GPM	810922			Y
092F047434	16	13	10	29474	2	113				4	4	GPM	821030			
092F047434	17	0	A	16485	2	128				40	1	USGM	850906			
092F047444	1	17	A	13495	1	150				2	20	GPM	750718			
092F057122	1	0	2	32878	4	300				3	0.5	GPM	850909			
092F057124	1	2	3	23698	4	240								Y	1400741	
092F057124	2	3	1	15992	4	12								Y		
092F057124	3	4	B	24913	4	178	30	18	-12	0	25	GPM	720407			
092F057124	4	5	14	15456	4	160	30	32	2	0	15	GPM	760426			
092F057124	5	6			4	96	4	130	126	8	7	GPM	720508			
092F057124	6	7	13	15456	4	152					36	GPM	720101	Y	1400740	
092F057124	7	8	14	15456	4	14	6	10	4					Y		
092F057124	8	9	1	15992	4	20							730101			
092F057124	9	10	19		4	37							740101			
092F057124	10	11	A	10241	4	95				2	0.3	GPM	750108			
092F057124	11	12	A	24913	4	186	26	12	-14	9			780601			
092F057124	12	16	C	18474	4	75				0	0.5	GPM	740602			
092F057124	13	17	15	15456	4	127				30	3	USGM	811010			Y
092F057124	14	18	2	15992	4	73	73	20	-53	28	2	USGM	811014			Y
092F057124	15	19	B	18474	4	100	15	90	75	7	5	GPM	831030			
092F057124	16	0	6	28762	4	120	16	150	134	13	1	GPM	860112			
092F057124	17	23	A	18474	4	120	110	20	-90	1	5	GPM	841104			
092F057142	1	2			13	10	8	75	67	5						
092F057142	2	3			13	12										
092F057142	3	4	REM		13	8										
092F057142	4	6	B	14744	13	83	12	50	38	0	5	GPM	721124			
092F057142	5	7	B	196561	13	110	12	50	38		6	GPM	680101	Y		
092F057142	6	8	A	14744	13	85	25	52	27	12	5	GPM	720512	Y		
092F057142	7	11	1	23347	13	20	8	138	130					Y		
092F057142	8	12			13	35				0	2	GPM	750804			
092F057142	9	13			13	35				0	30	GPM	750804			
092F057142	10	14			13	86				0	30	GPM	750804			
092F057142	11	17			13	38	15	110	95	15	15	USGM	811026			Y
092F057142	12	18	A	22322	13	40	15	126	111	7	10	GPM	820527			
092F057144	1	1			13	8	3	62	59	2	1.3	GPM				
092F057144	2	1			14	8							400101	Y	1400644	
092F057211	1	1			3									Y	1400742	
092F057211	2	20	2		4	290				5			720701			
092F057212	1	1	A	24183	5	20								Y	1400726	
092F057212	2	1			2	7										
092F057212	3	4			6	60	15	140	125	40	0.5	GPM	570101			
092F057212	4	14	4	29474	2	63	30	390	360	2	3	GPM	830105			

052F057212	5	0	1	29474	2	177				11	2	GPM	660707			
052F057212	6	48	3	26598	1	198	20	180	160	5	3	GPM	800105	Y		
052F057212	7	61	2	30505	1	200				4			810630			Y
052F057213	1	1			4									Y		
052F057213	2	1	C		4	76	40	220	180	0	12	GPM	720410			
052F057213	3	2	B	D5019N	4									Y	1400753	
052F057213	4	3			4									Y		
052F057213	5	4	6	32878	4	66					10	GPM	780101			
052F057213	6	5	7		4	285				2			780601			
052F057213	7	6	7	32878	4	300				3			780701			
052F057213	8	13	4	28762	4	90					7	GPM	750704			
052F057213	9	14	2	28762	4	100				57	4	GPM	711001			
052F057213	10	15	17	23668	4	96	15	158	143	14	3	GPM	790201			
052F057213	11	0				120				19			850128			
052F057214	1	0	C	30067	5	75				30	12	GPM	740916			Y
052F057214	2	3	D	30067	5	60	5	140	135	4	10	GPM	800301			Y
052F057214	3	4	H	30067	5	108	8	138	130	12	2	GPM	800201			Y
052F057214	4	5	I	30067	5	90	2	151	149	12	15	GPM	800201			Y
052F057214	5	6	B	30067	5	63	4	210	206		50	GPM	800201			Y
052F057214	6	7	A	30067	5	25	9	255	246		7	GPM	820401			Y
052F057214	7	8	D	30067	5	56	18	147	129	3	1	GPM	821010			
052F057214	8	9	A	30067	5	25	19	250	231	15	3	GPM	820420			
052F057214	9	24	2		6									Y		
052F057214	10	28	A	15182	10	93	15	78	63	3	5	GPM	831012			
052F057214	11	32	3	26454	6	75	10	100	90	3	1	GPM	771101			
052F057214	12	54	1	26454	6	96				6	4	USGM	810820			Y
052F057214	13	59	3	26454	6	42	22	105	83	6	5	GPM	820422			
052F057221	1	1	2	22977	1	7							580101			
052F057221	2	2			1	15										
052F057221	3	3			1	78	12	80	68	0	30	GPM	720428	Y	1400745	
052F057221	4	4	59	22184	1	203				0	2	GPM	720824	Y	1400743	
052F057221	5	5	204	24327	1	85	40	135	95		3	GPM	740101	Y	1400744	
052F057221	6	6	254	24327	1											
052F057221	7	7	18	24327	1									Y		
052F057221	8	8	104	24327	1	10		52	52							
052F057221	9	8			6	10	4	50	46					Y	1400735	
052F057221	10	9	65	24327	1											
092F057221	11	10	181	24327	1	10										
092F057221	12	11	50	22184	1	159					1.5	GPM	730101	Y		
052F057221	13	11	1	23972	6	40	12	20	8	0	10	GPM	720815	Y	1400725	
052F057221	14	12	120	24327	1	160							740701			
052F057221	15	13	118	24327	1	50					1	GPM				
052F057221	16	13	13	21282	6	200								Y	1400739	
052F057221	17	14	23	22184	1	50				3	15	GPM	741001			
052F057221	18	15	68	22184	1	100	12	20	8	7	2	GPM	770427			
052F057221	19	16	36	22184	1	176	6	40	34	4	10	GPM	750807			
092F057221	20	18	141	24327	1	150				3			770101			
092F057221	21	18	D	24773	6	50					5	GPM	740701			
092F057221	22	19	D	21923	6	35				8			720101			
052F057221	23	19	32	22184	1	125	25	128	103	5	3	GPM	770621			
092F057221	24	20	43	22184	1	150				4	0.5	GPM	780901			
092F057221	25	21	57	22184	1	126	22	28	6	5	3	GPM	771201			
092F057221	26	22	A	500230	1	177				2	5	GPM	780301			
052F057221	27	23	161	24327	1	80	10	98	88	4	3	GPM	760101			
052F057221	28	23			6	15								Y	1400749	
092F057221	29	24			1	169				0	3	GPM	741001			
092F057221	30	25	83	24327	1	50	8	55	47	0	30	GPM	760601			
092F057221	31	26	37	22184	1	250				2			770601			
092F057221	32	27	37	22184	1	169	15	50	35	2	8	GPM	770720			
092F057221	33	28	55	22184	1	123	30	28	-2	4	10	GPM	780801			
052F057221	34	28	10	23972	6	40					6	GPM	730701	Y		

092F057221	35	29	12	23972	6	100							730101			
092F057221	36	29			1	123	45	115	70	6	2	GPM	760101			
092F057221	37	30	2	26598	1	144				0	2	GPM	801106	Y		
092F057221	38	30	15	23972	6	105							740801	Y		
092F057221	39	31	11	21282	6	76				8	20	GPM	770101			
092F057221	40	31	1	30505	1	500				0			791205			
092F057221	41	32	71	22184	1	150				8			800629			
092F057221	42	33	3	22184	1	165				7	5	GPM	790701			
092F057221	43	33	16	23972	6	24				5	5	GPM	740407			
092F057221	44	34	8	23972	6	60				2			770428			
092F057221	45	34	125	24327	1	222	10	50	40	8	10	GPM	790401			
092F057221	46	35	159	24327	1	200				4	1	GPM	780401			
092F057221	47	35	3	23972	6	85	15	106	91	10	15	GPM	780801			
092F057221	48	36	4	23972	6	41				6	6	GPM	750114			
092F057221	49	36	186	24327	1	200				2	2	GPM	800301			
092F057221	50	37	234	24327	1	78	10	90	80	45	6	GPM	780101			
092F057221	51	37	14	23972	6	105				10	20	GPM	770101			
092F057221	52	38	54	22184	1	162				6	5	GPM	781001			
092F057221	53	39	140	24327	1	65				3	20	GPM	790301			
092F057221	54	40	168	24327	1	132	20	130	110	6	1	GPM	790401			
092F057221	55	41	166	24327	1	55				3	5	GPM	790501			
092F057221	56	42	137	24327	1	215	30	50	60	3	4	GPM	800101			
092F057221	57	42	3	23972	6	24				5	2.5	GPM	770501			
092F057221	58	43	119	24327	1	178				2	4	GPM	770127			
092F057221	59	44	61	22184	1	135				15	3	GPM	790501			
092F057221	60	45	13	22184	1	205	10	50	40	4	10	GPM	790501			
092F057221	61	45	12	21282	6	100				6			790501			
092F057221	62	46	14	23972	6	55	53	75	22	4	2	GPM	800704			
092F057221	63	46	147	22184	1	168				3	2	GPM	801101			
092F057221	64	47	13	22184	1	65	25	49	24	6	10	GPM	790501			
092F057221	65	48	8	23972	6	125				12	10	GPM	790912			
092F057221	66	49	8	23972	6	335				15	0		790401			
092F057221	67	49	241	24327	1	82				32	5	GPM	790918			
092F057221	68	50	227	24327	1	144	30	69	69	28	5	USGM	810520			Y
092F057221	69	51	232	24327	1	50	20	102	82	30	3	USGM	810412			Y
092F057221	70	52	91	24327	1	327				3			800830			
092F057221	71	52	C	21923	6	50	28	100	72	15	5	USGM	810731			Y
092F057221	72	53	210	24327	1	136	6	60	54	0	5	USGM	811114			Y
092F057221	73	54	183	24327	1	28				0	28	USGM	810807			Y
092F057221	74	55	144	24327	1	160				8	2	USGM	810318			Y
092F057221	75	56	218	24327	1	150	18	90	72	1	4	USGM	810620			Y
092F057221	76	56	13	23972	6	134				8			760218			
092F057221	77	57	13	23972	6	200				11			760211			
092F057221	78	57	219	24327	1	97				2	5	USGM	810905			Y
092F057221	79	58	244	24327	1	145	30	102	72	60	3	USGM	810514			Y
092F057221	80	59	256	24327	1	155	135	100	-35	58	0.5	USGM	810806			Y
092F057221	81	60	117	24327	1	230	150	70	-80	0	1	GPM	760331			Y
092F057221	82	62	5	26598	1	57				0	5	GPM	741030			Y
092F057221	83	63	2	26598	1	253	15	151	136	0	5	GPM	840309	Y	E105919	
092F057221	84	63	13	23972	6	25				8	5	GPM	760213			
092F057221	85	64	7	23972	6	120				0	0.7	GPM	820721			
092F057221	86	64	171	24327	1	258				1	0.2	GPM	821030			
092F057221	87	65	20	23184	1	165	25	115	90	2	5	GPM	830603			
092F057221	88	65	20	23972	1	154				5			860808			
092F057221	89	66	123	24327	1	261				3	5	GPM	840220			
092F057221	90	67	92	24327	1	250				0	0.3	GPM	830715			
092F057221	91	67	B	30442	6	60	6	56	50	6	0.2		861211			
092F057221	92	68	31	22184	1	200				0	5	GPM	820621			
092F057221	93	69	49	22184	1	186				0	0.2	GPH	840702			
092F057221	94	70	189	24327	1	200				2	20	GPM	820420			
092F057221	95	71	208	24327	1	183	163	90	-73	4	5	GPM	840512			

092F057221	96	72	224	24327	1	150				12			820415			
092F057221	97	73	236	24327	1	133				4	1	GPM	820730			
092F057221	98	74	235	24327	1	60				10	7	GPM	820425			
092F057221	99	75	6	22977	1	150				0	5	GPM	820601			
092F057221	100	76	157	24327	1	150	4	118	114	12	1	GPM	860116			
092F057221	101	77	90	24327	1	250				3			850630			
092F057221	102	78	103	24327	1	68	12	38	26	10	3	GPM	860710			
092F057221	103	79	28	22184	1	172	20	113	93	2	1	USGM	840801			
092F057221	104	80	229	24327	1	129	60	110	50	0	0.6	GPM	840320			
092F057221	105	81	250	24327	1	60	35	140	105	3	4	GPM	840326			
092F057221	106	82	167	24327	1	150				9	0.4	GPM	851220			
092F057221	107	83	195	24327	1	100	39	122	83	2	1	GPM	860730			
092F057221	108	84	221	24327	1	100	40	102	62	0	3	GPM	860520			
092F057221	109	85	246	24327	1	100	12	88	76	32	3	GPM	850715			
092F057221	110	86	16	22184	1	100				6			840701			
092F057221	111	87	19	22184	1	150	146	30	-116	2	5	GPM	841120			
092F057221	112	88	84	24327	1	50	8	103	95	5	5	GPM	860522			
092F057223	1	1	A	17817	6	125				48	10	GPM				
092F057223	2	2			6	12	3	45	42					Y	1400736	
092F057223	3	3			6	10	4	35	31							
092F057223	4	5	1	8189	6	125	0	20	20	50	1	GPM	690702			
092F057223	5	6	1	8189	6	110	3	31	28	30	14	GPM	690708			
092F057223	6	7	1	8189	6	225	34	35	1	3	1	GPM	690715			
092F057223	7	9	A	24773	6	125	0	83	83	0	10	GPM	720715			
092F057223	8	10	1	14068	6	152	0	32	32	0	10	GPM	720603			
092F057223	9	12			6	48				8	6	GPM	680712			
092F057223	10	14		17817	6	80					0			Y	1400738	
092F057223	11	15	1	14369	6	22								Y	1400737	
092F057223	12	16			6	60					3	GPM	740601	Y		
092F057223	13	17	B	24773	6	56	40	84	44		25	GPM	740801	Y	1401528	
092F057223	14	20	A	22755	6	150							740301	Y		
092F057223	15	21	5		6	120										
092F057223	16	22	16	14068	6	14	10	72	62					Y		
092F057223	17	25			6	110					30	GPM	740101			
092F057223	18	26			6	150					40	GPM	740101			
092F057223	19	27	1	14369	6	15					0		720101	Y	1400746	
092F057223	20	38	1	21282	6	58				3	15	GPM	750206			
092F057223	21	39	1	14369	6	100				0			780901			
092F057223	22	40	14	31738	6	50	20	34	14	10	30	GPM	751222			
092F057223	23	41	8	14068	6	200				6	1	GPM	780101			
092F057223	24	43	2	14068	6	102				8	10	GPM	781101			
092F057223	25	44	9	21284	6	82	30	50	20	3	8	GPM	791018			
092F057223	26	47	16	31738	6	48	16	81	65	7	4	GPM	791015			
092F057223	27	50	18	14068	6	51				5	8	GPM	741001			
092F057223	28	51		30067	6	159	20	42	22	48			790901			
092F057223	29	53	2	31728	6	160				8			770711			
092F057223	30	55	2	31728	6	151				5			770705			
092F057223	31	58	9	14068	6	50				8	5	GPM	830101			
092F057223	32	60	A	15657	6	150	10	32	22	24	3	GPM	820626			
092F057223	33	61	3	21282	6	187	15	49	34	13	0.5	GPM	821010			
092F057223	34	62	3	21282	6	109				8	5	GPM	831009			
092F057223	35	66	A	30464	6	120	110	30	-80		1.5	USGM	841030			
092F057223	36	68	A	30464	6	30	26	35	9		5	GPM	841030			
092F057223	37	69	1	26301	6	77	20	21	1	17	3	GPM	820210			
092F057224	1	1	A	21814	8	300	10	180	170	12	1	GPM	800301			
092F057224	2	2	29	23650	9	13	2	18	16							
092F057224	3	3	29	23650	9	12	8	25	17					Y	1400752	
092F057224	4	6				277	4	18	14	19	0.3	GPM	720701			
092F057224	5	10	C	24132	9	185				19			720529			
092F057224	6	66	C	24132	8	400				2	0.2	GPM	861031			
092F057231	1	1			12									Y		

062FC57231	2	5			12											
062F057231	3	5			13	144				12	0.7	GPM	701029	Y	1400724	
062F057231	4	16	1	25289	13	142				10	0.7	GPM	810701			Y
062F057232	1	2		1904R	11	150	35	165	130	0	20	GPM	720524	Y	1400731	
062F057232	2	3			11	60	6	180	174	4	8	GPM	740601	Y	1400722	
062F057232	3	4			11	15					0		730101	Y		
062F057232	4	6	4	28020	11	89	20	130	110	4	15	GPM	771101			
062F057232	5	7	D	28667A	11	137	4	202	198	5	10	GPM	770222			
062F057232	6	8			11	60				8			780401			
062F057232	7	9	1	31932	11	110				3			781201			
062F057232	8	9	A	1582	10	14										
062F057232	9	10	3	26332	10	50	20	125	105	0	20	GPM	760101			
062F057232	10	11	12	28020	11	106	60	160	100		10	GPM	780701			
062F057232	11	12	10	28020	11	100	20	124	104	6	25	GPM	750827			
062F057232	12	13	9	28020	11	64	20	124	104	9	5	GPM	800601			
062F057232	13	14	1	25797	10	84	4	78	74	8	30	GPM	780701			
062F057232	14	15	2	28020	11	175	165	142	-23	2	0.5	USGM	810630			Y
062F057232	15	16	13	28020	11	88				6	2	GPM	811023			
062F057232	16	17	11	28020	11	109	18	126	108	6	10	GPM	821030			
062F057232	17	18	14	28020	11	67	20	155	135	6	3	GPM	820422			
062F057232	18	19	14	28020	11	58				5			820511			
062F057232	19	20	A	1304R	11	300	14	170	156	11	1	GPM	831123			
062F057232	20	21	A	1304R	11	300	20	172	152	6	1.5	GPM	831124			
062F057232	21	22	6	28020	11	120				3	3	GPM	860606			
062F057232	22	29	B	39902	10	81	14	118	104	4	3	GPM	830606			
062F057232	23	31	A	34123	10	100	20	115	95	3			850717			
062F057233	1	1			15	12	8	33	25							
062F057233	2	2			15											
062F057233	3	2			12	6										
062F057233	4	3			12	17								Y		
062F057233	5	3			15											
062F057233	6	4	2	28472	15	66	12	250	238	3	15	GPM	771101			
062F057233	7	4			12	4								Y		
062F057233	8	5	1	28472	15	129				0	3	GPM	750801			
062F057233	9	6	D	24652	15	102				57			790901			
062F057233	10	6	1	21865	12	200				170	4	GPM	800310			
062F057233	11	7	1	24652	12	140	5	110	105	30	10	GPM	790601			
062F057233	12	7		24652	15	60				14	2	GPM	790701			
062F057233	13	8			15	120	20	106	86		2	GPM	800125			
062F057233	14	8	H	24652	12	200				60	15	USGM	811009			Y
062F057233	15	9	2	25289	13	10								Y		
062F057233	16	9	3	28472	15	198	168	105	-63	2	1	GPM	801022			
062F057233	17	10	E	24652	15	205	100	100		100	5	GPM	790823			
062F057233	18	10	1	25289	13	8								Y		
062F057233	19	11			15	66	8	165	159	5	30	GPM	790701			
062F057233	20	12			15	262				5			790815			
062F057233	21	13	1	28472	15	93	10	75	65	3	5	GPM	831010			
062F057233	22	15	2	25289	13	40				10	10	GPM	790701			
062F057233	23	19	1	25289	13	33	8	96	88	6	5	GPM	830820			
062F057234	1	1			16	3										
062F057234	2	1			11	98				5	8	GPM	680520			
062F057234	3	3	32			115				2	0.08	GPM	680707			
062F057234	4	5	87	24177	16	137	0	75	75	0	3	GPM	720918	Y	1400730	
062F057234	5	5	5	28020	11	97				3	2.5	GPM	770722			
062F057234	6	7	89		16	6							730101	Y		
062F057234	7	8	26	19701	16	150	8	75	67	6	4	GPM	751201			
062F057234	8	9	31	20269	16	180				2	0.2	GPM	751020			
062F057234	9	10	101	24177	16	250				150			760101			
062F057234	10	11	30	19701	16	196				5			740430			
062F057234	11	14	6	22132	16	123	40	60	20	1	0.03	GPM	760101			
062F057234	12	14	1	28020	11	26				0	7	USGM	810703			

092F057234	13	15	54	24177	16	72	5	70	65	5	15	GPM	751008			
092F057234	14	16	B	30237	16	27	3	87	84	2	16	GPM	771101			
092F057234	15	19	90	24177	16	45				3	5	GPM	781201			
092F057234	16	20	68	24177	16	190	20	69	49	4	2	GPM	801004			
092F057234	17	21	75	24177	16	55	8	50	42	8	0.5	GPM	790701			
092F057234	18	22	76	24177	16	45				26	2	GPM	800101			
092F057234	19	23	C	30237	16	250	15	119	104	2	0.5	GPM	781201			
092F057234	20	24	K	30237	16	35	5	78	73	3	20	GPM	800806			
092F057234	21	25	A	30237	16	100				4	0.7	GPM	800720			
092F057234	22	26	16	22132	16	250				10	1	GPM	760401			
092F057234	23	27	F	30237	16	50	20	74	54	1	2	GPM	801130			
092F057234	24	28	93	24177	16	75				10	10	GPM	790701			
092F057234	25	29	1	20269	16	110	40	65	25	1	6	GPM	801210			
092F057234	26	30	L	30237	16	242				3	0.12	GPM	810415			
092F057234	27	31	24	20269	16	175				7	0.2	GPM	810817			
092F057234	28	32	10	22132	16	271				6			810614			
092F057234	29	33	18	20269	16	154				0	3	GPM	810506			
092F057234	30	34	13	20269	16	150				0			810314			
092F057234	31	35	96	24177	16	26	2	68	66	8	20	GPM	801217			
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092F057234	33	39	24	22132	16	50	20	40	20	9	5	GPM	820914			
092F057234	34	40	96	24177	16	200				8			820630			
092F057234	35	41	62	24177	16	200				1	10	GPM	820730			
092F057234	36	42	10	1235	16	100	20	50	30	37	5	GPM	820925			
092F057234	37	43	9	1235	16	176				34	2	GPM	820830			
092F057234	38	44	6	1235	16	51	10	43	33	30	3	GPM	820925			
092F057234	39	45	7	1235	16	57	15	43	28	30	2	GPM	820925			
092F057234	40	46	8	1235	16	100	20	43	23	29	5	GPM	820925			
092F057234	41	47	5	1235	16	49	10	43	33	16	5	GPM	820709			
092F057234	42	48	3	1235	16	80	20	34	14	7	2	GPM	820924			
092F057234	43	49	2	1235	16	51	10	35	25	5	3	GPM	830101			
092F057234	44	50	1	1235	16	51	10	34	24	8	3	GPM	820920			
092F057234	45	52	D	30237	16	142	40	82	42	3	6	GPM	840830			
092F057234	46	53	56	24177	16	291				8			860520			
092F057234	47	54	32	22132	16	158				3			840330			
092F057234	48	55	15	22132	16	300				1	0.2	GPM	831025			
092F057234	49	57	38	20269	16	110				4			850711			
092F057234	50	0	5		16	78				20			840807			
092F057241	1	1	A	18085	10	80	13	60	47	11	14	GPM	770901			
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092F057241	5	5			10	175	6	10	4							
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092F057241	8	7			10	150	20	10	-10		5	GPM	690703		1400733	
092F057241	9	10	B	18085	10	60	15	62	47	0	3	GPM	720526	Y	1400732	
092F057241	10	11	A	20437	10	15										
092F057241	11	12			10	18	12	61	49					Y		
092F057241	12	13	A	18085	10	16								Y		
092F057241	13	15			10	200				6			741219			
092F057241	14	16			10	250	15	50	35	10	3	GPM	760501			
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092F057241	16	18			10	39				32			741219			
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092F057241	18	22	A	17975	10	40				10	3	GPM	780901			
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092F057241	20	23	50	19660	9	182				1			771201			
092F057241	21	24	4	25797	10	70				4	3	GPM	790101			
092F057241	22	25			10	82	14	51	37	10	20	USGM	800711			
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092F057241	24	30	6	26332	10	200				8	0.08	GPM	861129			
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092F057241	26	45	44	19660	9	241	50	20	-30	30	20	GPM	800526			
092F057241	27	49	10	23616	9	45				6	10	USGM	810112			
092F057241	28	53	4	23616	9	91	15	33	18	79	1	USGM	810908			Y
092F057241	29	54	53	19660	9	241	201	20	-181	0	8	GPM	810605			Y
092F057241	30	68	8	23616	9	240	11	33	22	6	2	GPM	860101			
092F057242	1	1			7	12	4	10	6							
092F057242	2	1	18	13036	9	100					0					
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092F057242	4	5	A	33078	7	235	10	12	2	57	0.5	GPM	850430			
092F057242	5	8	9	21814	9	385	105	105		7	0.5	GPM	720819			
092F057242	6	9	11	25736	9	250	10	18	8	21	0.03	GPM	720801			
092F057242	7	11	6	13036	9	12							700101	Y		
092F057242	8	12	24	23616	9	16							720101	Y	1400751	
092F057242	9	13	A	19879	9	15								Y	1400750	
092F057242	10	14	16	13036	9									Y		
092F057242	11	16	30	13036	9	7								Y		
092F057242	12	17	F	23649	9	151	20	35	15	3			770731			
092F057242	13	18	4	19660	9	100				3	2	GPM	780801			
092F057242	14	19	8	19660	9	102	10	15	5	3	0.5	GPM	770714			
092F057242	15	20	19	23616	9	63	2	24	22	8	20	GPM	760101			
092F057242	16	21	36	19660	9	110	10	21	11	5	10	GPM	780801			
092F057242	17	24	23	19660	9	150				8			750905			
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092F057242	31	40	21	23616	9	75	1	22	21	5	6	GPM	790901			
092F057242	32	41	22	23616	9	65	5	10	5	4	3	GPM	801029			
092F057242	33	42	22	19660	9	67	1	25	24	8	10	GPM	790906			
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092F057242	35	44	4	23650	9	245				8			800830			
092F057242	36	46	28	23650	9	166				6	0.25	GPM	790323			Y
092F057242	37	47	G	23649	9	200				8			810302			
092F057242	38	48	14	23616	9	250	75	25	-50	3			800101			Y
092F057242	39	50	15	23616	9	22				7	10	USGM	810910			
092F057242	40	51	38	19660	9	317				6			810220			Y
092F057242	41	52	29	19660	9	146				4			811105			Y
092F057242	42	55	3	2360	9	50	40	10	-30	18	5	USGM	810330			
092F057242	43	56	12	19660	9	196				13	0.5	GPM	830217			
092F057242	44	57	J	23649	9	100	5	30	25	4	1	GPM	830128			
092F057242	45	58	18	23616	9	120	4	28	24	1	10	GPM	830101			
092F057242	46	59	21	19660	9	154	146	5	-141	6	3	GPM	840430			
092F057242	47	60	24	19660	9	288				3	4	GPM	830521			
092F057242	48	61	33	19660	9	90				1	10	GPM	830905			
092F057242	49	62	3	13036	9	150	5	5		29	0.2	GPM	810211			
092F057242	50	63	8	13036	9	100				16		GPM	810323			
092F057242	51	64	8	30859	9	150				3	0.08	GPM	841004			
092F057242	52	65	A	14885	9	265	65	8	-57	1	2	GPM	851230			
092F057242	53	67	1	23650	9	226	12	11	-1	45	2	GPM	850730			
092F057242	54	69	M	23649	9	201	30	39	9	3	5	GPM	860415			

062F057242	55	70	6	25736	9	64	4	32	28	3	10	GPM	830124			
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062F057243	1	1	A		17	207	40	46	6	0	6	GPM	721125	Y	1400747	
062F057243	2	2			17	8	6	51	45							
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062F057243	4	4			17	20	15	43	28							
062F057243	5	5			17	10								Y	1400748	
062F057243	6	6			17	62							740101			
062F057243	7	7			17	120	8	47	39	27	3	GPM	741024			
062F057243	8	8			10	190					1	GPM				
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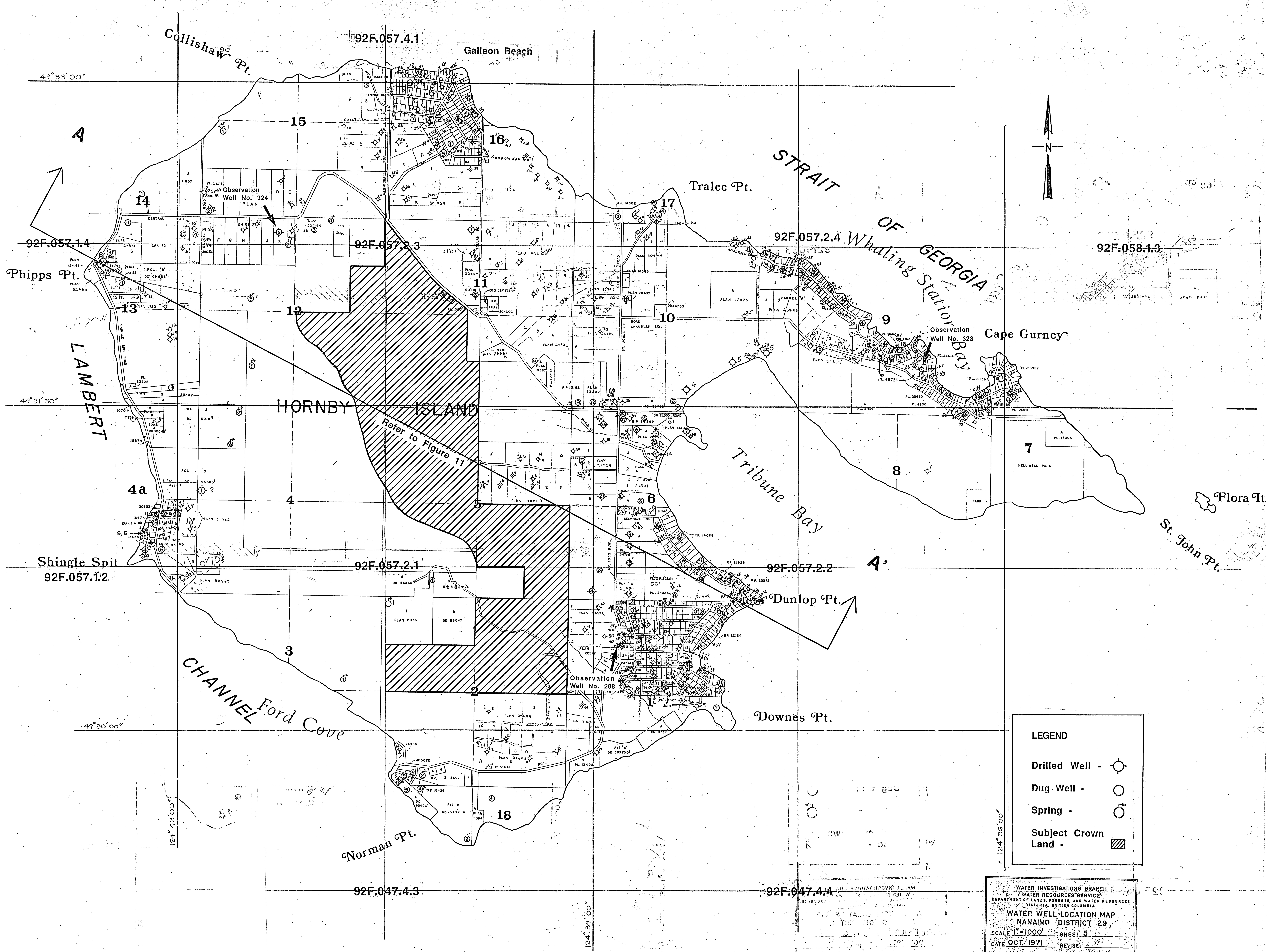
062F057243	10	9	3	30656	17	80				52	4	GPM	770101			
062F057243	11	10	2	30656	17	209				58	5	GPM	821008			
062F057243	12	19	3	30844	10	170	6	51	45	14	0.5	GPM	760922			
092F057243	13	21	6		10	150	10	22	12	10	2	GPM	791026			
062F057243	14	23	5		10	110				10	1	GPM	730801			
062F057243	15	27	2	30844	10	200				36	1	USGM	810130			
062F057412	1	2	11		16	68				5			680706			
062F057412	2	4			16	340				6	0.08	GPM	680629			
062F057412	3	6	17	19701	16	212	3	28	25	0	3	GPM	720830	Y	1400729	
062F057412	4	12	11	19701	16	106				4	15	GPM	750501			
062F057412	5	13	9	16701	16	164	40	40		6	0.2	GPM	770804			
062F057412	6	17	5	16701	16	144				8	8	GPM	800926			
062F057412	7	18	21	20269	16	170				0	30	GPM	800912			
062F057412	8	36	7	16701	16	278							831207			
062F057412	9	37	4	16701	16	130	20	10	-10	2	3	GPM	820518			
062F057412	10	51	8	16701	16	100	66	10	-86	0	5	GPM	850318			
062F057412	11	56	3	19701	16	37	6	18	12	5	10	GPM	851109			
062F058131	1	2	1	21328	7	83				0	20	GPM	720510			
062F058131	2	3			7	82				8			720501	Y	1400723	
062F058131	3	4			7									Y		



To Accompany Report on:

A Groundwater Assessment of a Crown Land Parcel on Hornby Island - 1993

Figure 5