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GROUNDWATER HYDROLOGIST (A.I.H. No. 280)

SUPPLEMENTAL REPORT

AUGUST 2007

EVALUATION OF GROUNDWATER FLOW FOR LOT 387 ON ASSESSOR'S MAP 9 ALSO DESIGNATED AS SEA LEA COLONY LOT 121 CHARLESTOWN, RHODE ISLAND

b) **Introduction.** Reference the original report entitled "Evaluation of Groundwater Flow for Lot 387 on Assessor's Map 9, also Designated as Sea Lea Colony Lot 121, Charlestown, Rhode Island" dated December 2006. This supplemental report evaluates the effects from a changed location of, and input to, the on-site sewage disposal system proposed for the site. The specific changes from the original report are:

   c) The location of the leach field is now 71 feet to both the existing and the proposed drinking water wells, as compared to the previous distance of 62 feet to the nearest well.
   d) The location of the septic tank is now 75 feet to the existing well as compared with the previous distance of 60 feet.
   e) The proposed individual sewage disposal system (ISDS) will be used only for "grey water". The toilet sanitary wastes will be handled by a separate composting system.
   f) Since the requirement for toilet flushing water is now eliminated, the requirement for water from the well is now reduced.

The revised site plan is attached herewith as Figure 1.

g) **ISDS Revision Effects.** The elimination of toilet waste from the ISDS greatly reduces both the nutrient and bacteriological input to the groundwater system. Only "grey water", specifically defined as waste water from bathing tubs and showers, sinks, dishwasher, and clothes washer will be passed to the ISDS. A composting toilet will handle "black water", or toilet wastes, with the residue to be disposed of off the site. This provides a reduction of about 70% of Kjeldahl nitrogen and 17 % phosphorus from the waste water stream that would otherwise pass to the ISDS (Canter and Knox, 1986). The highly efficient denitrification component of the Advantex ISDS unit planned for the site is expected to remove approximately 70 % of the nitrogen entering the system, effectively reducing the contribution to groundwater to less than 10% of that produced by the planned residential unit. The phosphate is effectively removed as it passes through the unsaturated soil underlying the

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leach field and represents no environmental or health concern. Because of the elimination of toilet wastes, the amount of micro-organisms will also be greatly reduced. Those remaining will be almost totally killed by the planned waste water ultra-violet disinfection unit of the ISDS. Any very small amount of human pathogens remaining are expected to die off in the hostile environment of the soil and groundwater system during travel, and will represent no hazard to human health or the environment

h) **Water Well Effects.** The reduced well water requirement because of the elimination of water flushed toilets, and the associated reduced waste water input to the groundwater, is a very positive benefit to the environment and to the groundwater system. It is estimated that the elimination of water flushing toilets will reduce the water requirement by about 30% in conventional systems (Canter and Knox, 1986). With the use of modern water efficient appliances it is estimated that the revised household water use is realistically about 35 gallons/day/capita with an additional 5 gallons/day/capita for miscellaneous water use and loss, for a total of 40 gallons/day/capita. The original report used a design planning amount of 75 gallons/day /capita. This reduced quantity directly affects the water well pumping requirement. The reduced figure results in an estimated average daily requirement of 160 gallons/day from the well, rather than the 300 gallons originally planned. The long term drawdown, including the effect from the neighboring well, 9 feet away, and assuming year round occupancy is 0.15 feet. The long-term increased effect of a new well on the existing well is 0.03 feet, essentially insignificant. On a short term during cyclic pumping at the rate of 5 gallons/minute, the drawdown in the well be greater, but pumping is only required for less than an hour each day and the groundwater equilibrium is quickly restored when pumping stops. Since essentially the same amount of water is returned to the ground though the ISDS there is no net adverse effect to the area groundwater system. Figure 2 is a conceptual vertical cross section depicting the long term effects of the well, the recharge chamber and the ISDS on the site water table relative to the groundwater flow system.

4.0 Conclusions.

a) The aquifer is a water table aquifer receiving recharge from precipitation, primarily during the period November to March and is sufficient to meet the modest requirements of the planned construction.

b) The subsurface material is composed of glacial sediments ranging from silt to gravel size with permeability (hydraulic conductivity) ranging from 20 to 100 ft/day and a porosity of about 20 %, a suitable soil for both sewage effluent disposal and low demand water wells.

c) The general pattern of the horizontal component of groundwater flow at the site continues to the north-northwest with discharge to the cove.

d) Area water quality is now good and would not be adversely affected by the planned construction.

e) Based on the assigned 2 bedroom criteria for the new well with a maximum anticipated groundwater use of 160 gallons/day, the effect of a new well on the naturally occurring pattern of groundwater flow is minimal.

f) Based on the assigned 2 bedroom criteria with a maximum effluent discharge of 140 gallons/day, the effect of a new on-site sewage disposal system (ISDS) at the location indicated is minimal.
g) The employment of directed roof discharge from the proposed new dwelling to discrete groundwater recharge can have beneficial effects for both the proposed new well and the adjacent existing well.

5.0 Supplemental References.

Canter, L. W. and R. C. Knox, 1986, Septic Tank System Effects on Ground Water Quality, Lewis Publishing Co. Chelsea, Michigan, pp 73-89.

Frisella Engineering, 2006 (rev. 2007) *Plan of Individual Sewage Disposal System*, for Sea Lea Lot 121, sheet 1 of 2.

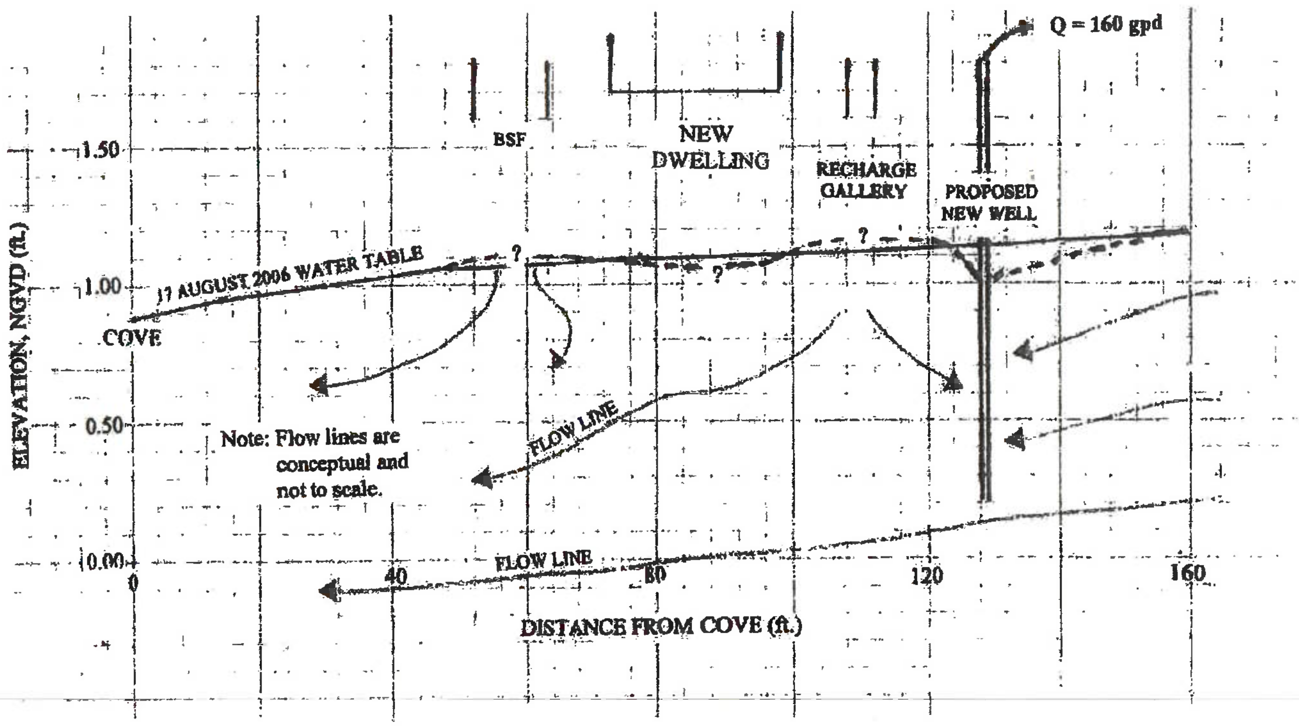

Figure 2. Conceptual Water Table Profile Showing Flow Lines at Cross-Section A-A'

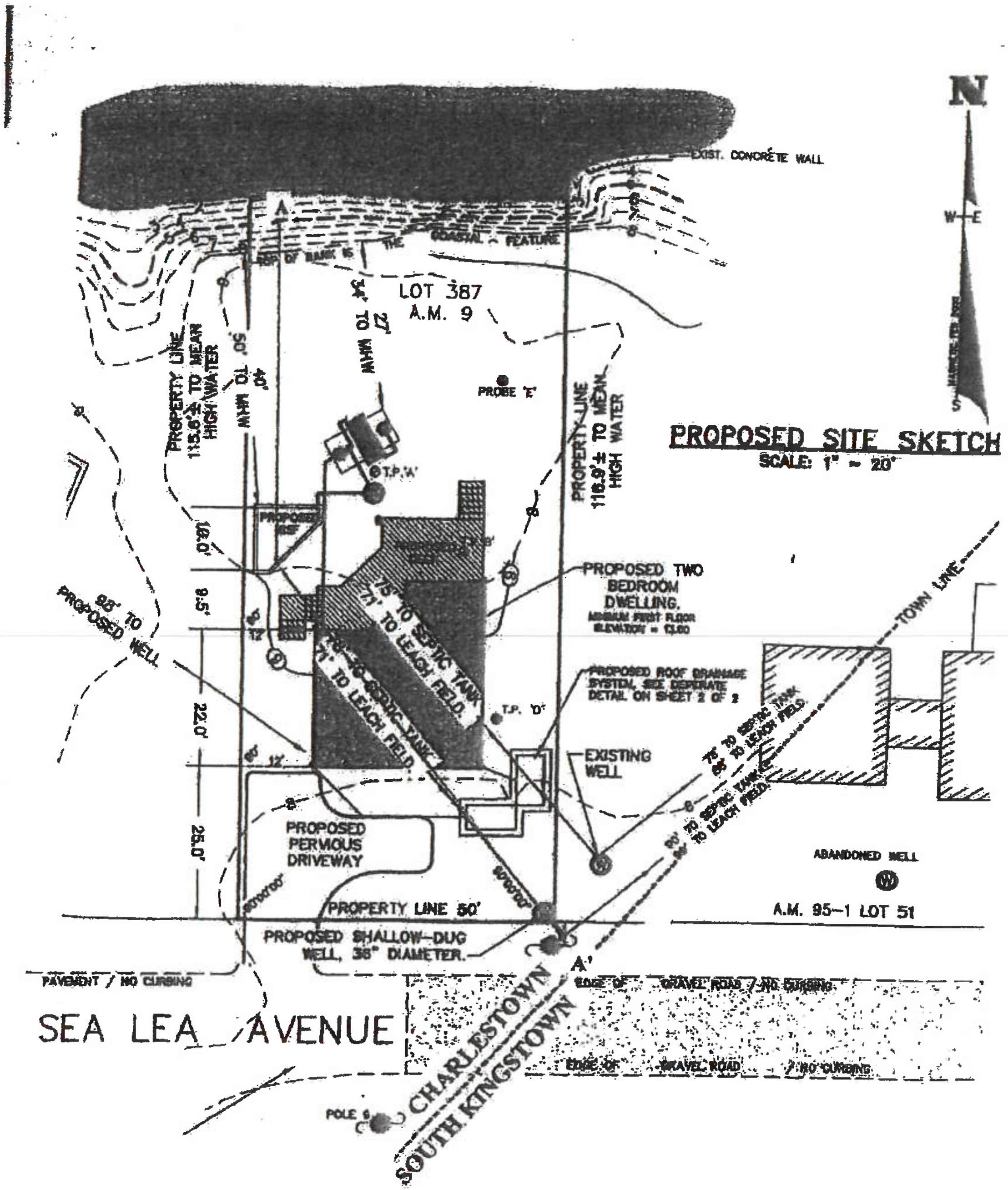

Figure 1. Site Development Plan for Lot 387 Showing Location of Cross-Section A-A'

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SUPPLEMENTAL REPORT Number 2

June 2009

EVALUATION OF GROUNDWATER FLOW FOR LOT 387 ON ASSESSOR'S MAP 9 ALSO DESIGNATED AS SEA LEA COLONY LOT 121 CHARLESTOWN, RHODE ISLAND

A) Introduction.

The following key references are relevant and important to reviewing this supplemental report.

b) Original Urish report entitled "Evaluation of Groundwater Flow for Lot 387 on Assessor's Map 9, also Designated as Sea Lea Colony Lot 121, Charlestown, Rhode Island" dated December 2006.

c) Supplemental Urish Report Number 1, dated August 2007,an evaluation of the effects from a changed location of the on-site sewage disposal system proposed for the site.

Purpose: The purpose of this Supplemental Report Number 2 is to evaluate the effect of revised DEM wastewater treatment system criteria and changed engineering plans on the proposed development of Lot 387, Assessor's Map 9, Narragansett, Rhode Island. Additionally, the discussion is directed to a focused response to the issues stated in DEM ltr. of July 24, 2008 to Bruce Gardner & Others regarding the denial of variances for site development.

The specific changes from the Original Report and Supplemental Report No. 1 are:

a) The required waste water flow for a 2 bedroom residential use as stated in DEM Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater treatment Systems (January 1, 2008) is now 115 gpd/bedroom rather than the 150 gpd/bedroom used in the original report. This greatly changes both the wastewater quantity, as well as the onsite water well requirement.

b) The "black water from toilet sanitary wastes will be handled with an incineration system, rather than composting, or conventional ISDS system. The proposed individual sewage disposal system (ISDS) will be used only for "gray water". This greatly reduces the potential for objectionable contributions to the site.

B) ISDS Revision Effects. The elimination of toilet waste from the ISDS greatly reduces both the nutrient and bacteriological input to the groundwater system. Only "gray water", specifically defined as wastewater from bathing tubs and showers, sinks, dishwasher, and clothes washer will be passed to the ISDS. An incineration toilet will handle "black water", or toilet wastes, with the residue to be disposed of off site. This provides a reduction of about 70% of Kjeldahl nitrogen and 17 % phosphorus from the waste water stream that would otherwise pass to the ISDS (Canter and Knox, 1986). With proper maintenance, the highly efficient denitrification component of the Advantex ISDS unit planned for the site is expected to remove approximately 70 % of the nitrogen entering the system, effectively reducing the final contribution to groundwater to less than 10% of that produced by a conventional residential unit. Additionally, the phosphate is effectively removed as it passes through the unsaturated soil underlying the leach field and represents no environmental or health concern. Because of the elimination of toilet wastes, the amount of micro-organisms will also be greatly reduced. Those remaining will be almost totally killed by the planned waste water ultra-violet disinfection unit of the ISDS. Any very small amount of human pathogens remaining are expected to die off in the hostile environment of the soil and groundwater system during travel, and will represent no hazard to human health or the environment.

b) **Water Well Effects.** The well water requirement is effectively reduced to 40 gpd/person from the original 75 gpd/person because of the elimination of water flushed toilets and the reduction of ISDS criteria from 150 gpd/bedroom to 115. The associated reduced waste water input to the groundwater, is a very positive benefit to the environment and to the groundwater system. It is estimated that the elimination of water flushing toilets will reduce the water requirement by about 30% in conventional systems (Canter and Knox, 1986). With the use of modern water efficient appliances it is estimated that the revised household water use is realistically about 35 gallons/day/capita with an additional 5 gallons/day/capita for miscellaneous water use and loss, for a total of 40 gallons/day/capita. This reduced quantity directly affects the water well pumping requirement. The reduced figure results in an estimated average daily requirement of 120 to 160 gallons/day from the well, rather than the 300 gallons originally planned. The long term drawdown in the proposed well is 0.05 ft. using the Thiem equation (Fetter, 2001). The long-term (assuming the well is pumped on a daily basis throughout the year) effect of a new well on the existing well is 0.02 feet, essentially insignificant. In practice recharge during the winter-spring period effectively eliminates the effects from low-use individual wells. On a short term during 4 periods of cyclic15-minute pumping at the rate of 3 gallons/minute, the immediate drawdown in the large diameter proposed well is 0.02 ft. using the Theis equation (Fetter, 2001). Pumping is only necessary for less than an hour each day to supply the required water use, and the groundwater equilibrium is quickly restored when pumping stops. The concurrent effect on the neighboring well 9 feet away is 0.01 ft, essentially zero.

As with all communities with limited water resources, water conservation is essential and must be practiced, especially with regard to lawn watering. In this regard, with the a restriction for water conservation for the proposed residential lot, the planned well will have essentially no impact on the rest of the neighborhood, who must exercise good conservation measures on their own.

Shallow well pollution. With regard to the DEM statement that "this groundwater is more at risk of pollution because it is more easily contaminated by surface or near-surface activity than deeper groundwater." This true, but is not relevant to the proposed well. The risk is from the activity at existing older wells, that in many cases are not properly constructed and protected. A properly constructed and maintained well can be safe.

Salt water intrusion. With regard to the DEM statement that "due to concerns for salt-water intrusion into deeper water bearing strata, the water supply (private wells) for the area is limited largely to the shallow-lying groundwater." Certainly, all area residents are ill-advised to put in deep wells. With properly constructed shallow wells there is little risk from salt water intrusion, and none that would be increased from the addition of the proposed well at Lot 387.

Area groundwater flow pattern. The DEM response of July 24, 2008 raised the concern that the models used were based on an average condition that may not be present in the summer months. Groundwater elevations and flow patterns were measured at 3 different periods in the year: January-February 2000 (Frisella Engineering; November 8, 11 and 14, 2005 (Urish); August 8, 9, 10 and 17, 2006 (Urish). The last set of measurements do reflect the conditions at the end of summer critical period in August. As noted in the data of the tables of the original report, there is expected variation in the elevations due to the influence of the tide on the "floating " fresh water lens. Additionally there is some seasonal variation, but this is greatly subdued as compared with a terrestrial situation because of the freshwater lens effect. In all cases the area groundwater flow pattern at the site is the same, to the north-northwest toward the pond. Since essentially the same amount of water is returned to the ground though the ISDS there is no net adverse effect to the area groundwater flow system from well water use.

4.0 Conclusions.

a) The aquifer is a water table aquifer (Ghyben-Herzberg lens type) receiving recharge from precipitation, primarily during the period November to March and is sufficient to meet the modest requirements of the planned construction.
b) The subsurface material is composed of glacial sediments ranging from silt to gravel size with permeability (hydraulic conductivity) ranging from 20 to 100 ft/day and a porosity of about 20 %, a suitable soil for both sewage effluent disposal and low demand water wells.
c) The general pattern of the horizontal component of groundwater flow at the site continues to the north-northwest with discharge to the cove both in winter and in summer.
d) Area groundwater quality is now good and would not be adversely affected by the planned construction.
e) Based on the assigned 2 bedroom criteria (DEM January 2008) for ISDS, the proposed well has a maximum anticipated groundwater use of 160 gallons/day. There is negligible effect of a new well on the naturally occurring pattern of groundwater flow.

f) Based on the assigned 2 bedroom criteria (DEM January 2008) which results in a maximum effluent discharge of 160 gallons/day, the effect of a new Advantex on-site sewage disposal system (ISDS) at the location proposed is minimal both on the groundwater flow pattern and on potential groundwater contamination.

5.0 Supplemental References.

Canter, L. W. and R. C. Knox, 1986, *Septic Tank System Effects on Ground Water Quality*, Lewis Publishing Co. Chelsea, Michigan, pp 73-89.

DEM, State of Rhode Island, *Rules Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems*, January 1, 2008.

Fetter, C. W., 2001, *Applied Hydrogeology*. Prentice-Hall, Upper Saddle River, N. J. pp150-169.

Frisella Engineering, 2006 (rev. 2007) *Plan of Individual Sewage Disposal System*, for Sea Lea Lot 121, sheet 1 of 2.