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Re: Assessment of Existing Stream Corridor – West and East Tributaries of Salt Creek through the Castlemore Golf Course.

Field Observations

A reconnaissance level field investigation was completed for the West and East tributaries of Salt Creek through the subject property on March 24, 2009. Various observations were made of the west and east tributaries, several of which are illustrated on the accompanying photo page.

The location of both tributaries appear to be highly influenced by local topography. It is clear that both tributaries have been modified in terms of their physical characteristics, including slope, adjacent vegetation and also either partially enclosed within culverts (the East Tributary) or removed to construct an online pond (the West Tributary). In addition, the surrounding topography has been significantly changed as part of the golf course design, including modifying topography immediately adjacent to both drainage features.

West Tributary:

- Currently only a relatively short section (165 m) of channel is free flowing. Within the remainder of the subject property, flows are directed through on-line ponds (i.e., 180 m).
- Grasses have been manicured to the water's edge.
- A short section of densely vegetated channel (i.e., cattail) occurs immediately upstream the second crossing downstream of Castlemore Road; here, the channel is poorly defined.
- The short section of channel (i.e., 25 m) that is immediately downstream of the second watercourse crossing and immediately upstream of the downstream pond appeared to have a steeper slope. The slope appeared to be highly influenced by anthropogenic factors (i.e., crossing outlet elevation and water elevation in the pond).
- Vegetation exerts an influence on channel form, as evidenced by a knickpoint in the channel bed profile. This knickpoint, occurring immediately downstream of a section of channel bed that was vegetated, was presumably due to a differential resistance between the vegetation and downstream materials. That is, characteristics of this

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vegetated section, and its rooting network, are resistant to the hydraulic stresses conveyed through the watercourse, and the sediment winnowing effects of flows.
- Several scour pockets were observed adjacent to the watercourse. None of these were directly connected to the watercourse or to each other. These features may have been created by hydraulic stresses or by opportunistic scour. The discontinuity of the features suggests that the vegetation interferes with/protects the floodplain from hydraulic shear forces
- Evidence of vegetation growing within the channel was observed on the channel bed in various locations – the lack of emergent vegetation during the site visit was presumably a function of season.
- Channel bed morphology (e.g., ‘pool’ and ‘riffle’ features) was subtle.
- Where the bed was exposed within the channel feature, this was characterized by clay materials. Accumulations of fine sand and small gravels did occur and appeared to coincide with some ‘riffle’ features. In other areas, no differentiation between ‘pool’ and ‘riffle’ bed materials was observed.
- Measurements of channel dimensions revealed a width range of : <0.25 m – 2.2 m; and a depth range of ~ 0.02 – 0.30 m
- The maximum lateral span of the planform configuration, including the observed scour pockets was measured to be approximately 6.5 m.
- The feature drains through a slight depression in the surrounding topography that has a maximum bottom width in the range of about 17 – 21 m which is also generally indicated by moisture and vegetation changes

East Tributary:
- The channel appears to have been previously straightened and lacks sinuosity.
- Grasses have been manicured through the drainage feature.
- The channel through the feature has a broad U-shaped configuration with difficult to discern banks.
- No flow was observed during the site visit, although some standing water was present.
- Total channel length through the subject property is 157 m, of which approximately 80 m are conveyed underground through 15” or 18” diameter corrugated steel pipes (CSP).
- At the downstream end of the subject property, channel definition becomes unclear as flows are conveyed through a densely vegetated (cattail) area. Cattail dominated sections occur both upstream and downstream of the subject property.

Preliminary Assessment of Corridor Width

Field observations suggest that both the west and east tributaries of Salt Creek are vegetation controlled or highly influenced by vegetation. During the reconnaissance site visit, two cross-section profiles were documented for the west tributary (i.e., for the channel section between the two ponds which was considered representative of site conditions) and two cross-section profiles were documented for the east tributary. Using the cross-section data, and topographic survey data for the drainage feature received from Candevcon, some analyses could be undertaken to gain insight into controls and functions of the two drainage features. These included the following:

Stream Type Assessment: Brookes (1985) has developed a classification system that documents the range of stream power that different stream types (i.e., step-pool, riffle-pool, anastomosing etc.) typically occur in the natural (i.e., unaltered) environment. This classification is a useful reference to determine whether the observed stream type is in fact sustainable given the quantified energy environment.
Stream Stability Assessment: Brookes (1988) has extended the stream power concept to defining general stream stability based on stream power.

Preliminary Findings: Field data were processed and analyzed to determine a dominant discharge for each of the cross-sections that were documented. Data were plotted on the Brookes curves (**Figure 1**) which revealed the following:

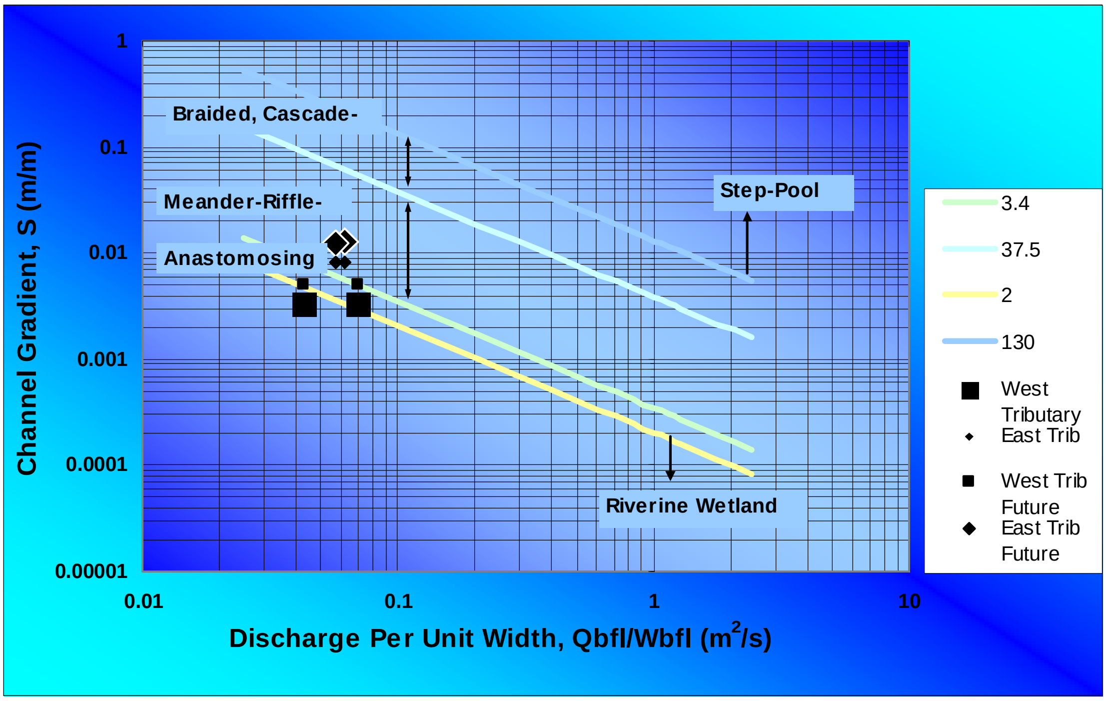

Figure 1. Stream Type according to Brookes (1985) Stream Power Classification.

West Tributary – data for the two cross-sections representing channel conditions between the two watercourse crossings (i.e., between the ponds) ponds were classified as riverine wetland or anastomosing. Both of these stream types are vegetation controlled. In such cases, the meander belt is not an applicable tool for defining the width of anticipated floodplain occupation by the watercourse since the meander belt presumes a shear stress dominated system. Channels that are highly vegetation controlled tend to be opportunistic and also influenced by topography.

An evaluation of future corridor slopes and implication to energy environment reveals that the channel is expected to remain vegetation controlled (riverine wetland or anastomosing) for the two upstream cross-sections. Review of **Figure 1** does show that some sections of channel may become transitional to a meander pool-riffle form.

Review of Brookes' (1988) stability classification revealed that the west tributary is considered to be 'generally stable' and may be close to a 'depositing' channel form. These results tend to verify field observations and the stream type according to Brookes' (1985) stream power classification.

East Tributary – Given the uniformity in cross-sectional configuration, one cross-section profile was documented in each of the unpiped channel sections within the study area. Analyses revealed that the stream type corresponding to the energy environment for both channel sections was meandering riffle-pool. This result was surprising given site observations of a fully intact grassed channel feature (i.e., no scour).

Under future anticipated channel corridor conditions (e.g., slope), the classification for the channel remains meandering riffle-pool, but is close to the boundary for anastomosing stream type. Hence, under proposed conditions, the energy environment is expected to decrease in comparison to existing conditions.

Review of Brookes' (1988) stability classification revealed that the east tributary is considered to be 'generally stable' channel form. This finding would suggest that although classified as a meandering riffle-pool form, that the field observations are in keeping with a stable existing channel configuration.

Preliminary Conclusion

Through the site reconnaissance and preliminary calculations, it appears that the meander belt is not an appropriate management tool for quantifying the channel corridor width for the west tributary, but may be appropriate for the east tributary. It should be noted however, that the preliminary results of stream type analyses for the east tributary seem contradictory to field findings/observations and it is recommended that more detailed work be undertaken to verify the results.

West Tributary
For the west tributary, quantification of a stream corridor width could be guided by the existing extent of lateral floodplain occupation. An allowance for some spatial change in floodplain occupation is recommended. Since channel relocation is proposed, then the proposed stream

corridor width should be in keeping with future restoration objectives and controls on channel form. In this case, since there may be a transition to the meander riffle-pool form, an Application of empirical meander belt relations to the setting could provide some insight into the relative magnitude of an appropriate corridor. Review of Williams (1986) and Aquafor relations suggest a meander belt of 9.10 m under existing conditions and 8.4 under proposed conditions are appropriate for this tributary.

As a headwater feature, it is recommended that headwater channel characteristics and functions be replicated which tend to be in keeping with a vegetatively controlled channel form rather than a meander riffle-pool feature. Hence, a meander belt width should only be used as a general guide to assist in determining an appropriate corridor for a vegetatively controlled channel form.

Site restoration for the proposed corridor characteristics should be in keeping with sustaining the appropriate stream type and the overall objectives of enhancing the physical, ecological and hydrologic function of the drainage feature.

East Tributary
For the east tributary, if a meander belt is to be defined, then this should be based on empirical relations that are applicable for the setting (i.e., low flow magnitude, upstream drainage area etc.). The only method that specifically includes data for watercourses similar in size to the east tributary is Williams 1986 equation and a relation developed by Aquafor that applies to headwater streams. The average result from all meander belt estimates (i.e., two equations for two cross-sections) is 6.25 under existing conditions and 6.75 m under proposed channel corridor conditions. However as stated previously, field results would suggest that a vegetatively controlled channel is the appropriate form.

Summary
It would appear that both channels are likely vegetatively controlled or perhaps transitional between a vegetatively controlled and meandering stream type. As noted above, further work should be undertaken to better assess whether the east tributary analytical results adequately reflect existing channel form and processes. Given the short sections of channel that could be assessed, it is not clear whether they are truly reflective of existing conditions. Further, it is not clear whether the vegetative treatments that exist within the drainage features (and particularly for the east tributary) are representative of natural vegetated systems, which would generally be more resistant to channel forming processes. Accordingly, it is our opinion that the final form of the restored channels and corridors should be governed by the most appropriate design that can meet the stated objectives for these channels, specifically:

- Replicate headwater channel form and functions, recognizing that Peel plain headwater systems typically originate as vegetatively controlled swale-type features that transition into meandering pool:riffle alluvial features as drainage area increases
- Create seasonal fish habitat where only support habitat currently exists

- Enhance refuge habitat for fish and re-create some of the pond/pool-like characteristics of the pond in some pool/wetland features within the created channel
- Enhance wetland habitat overall, by increasing the amount of online and offline wetland features as much as is feasible
- Provide for good transition areas from flows entering the subject lands and for flows leaving the subject lands. These transition areas are best designed as pool/wetland features
- Increase food production in the form of aquatic organisms in a seasonal environment to support downstream fish habitat. This is best accomplished, in seasonally flowing headwater features, through the creation of pool/wetland features that retain water during periods of no flow to support survival of aquatic food organisms.