Ricardo Ranch Flood Fringe Study

Report

January 2020

02

Ricardo Ranch
Flood Fringe Study

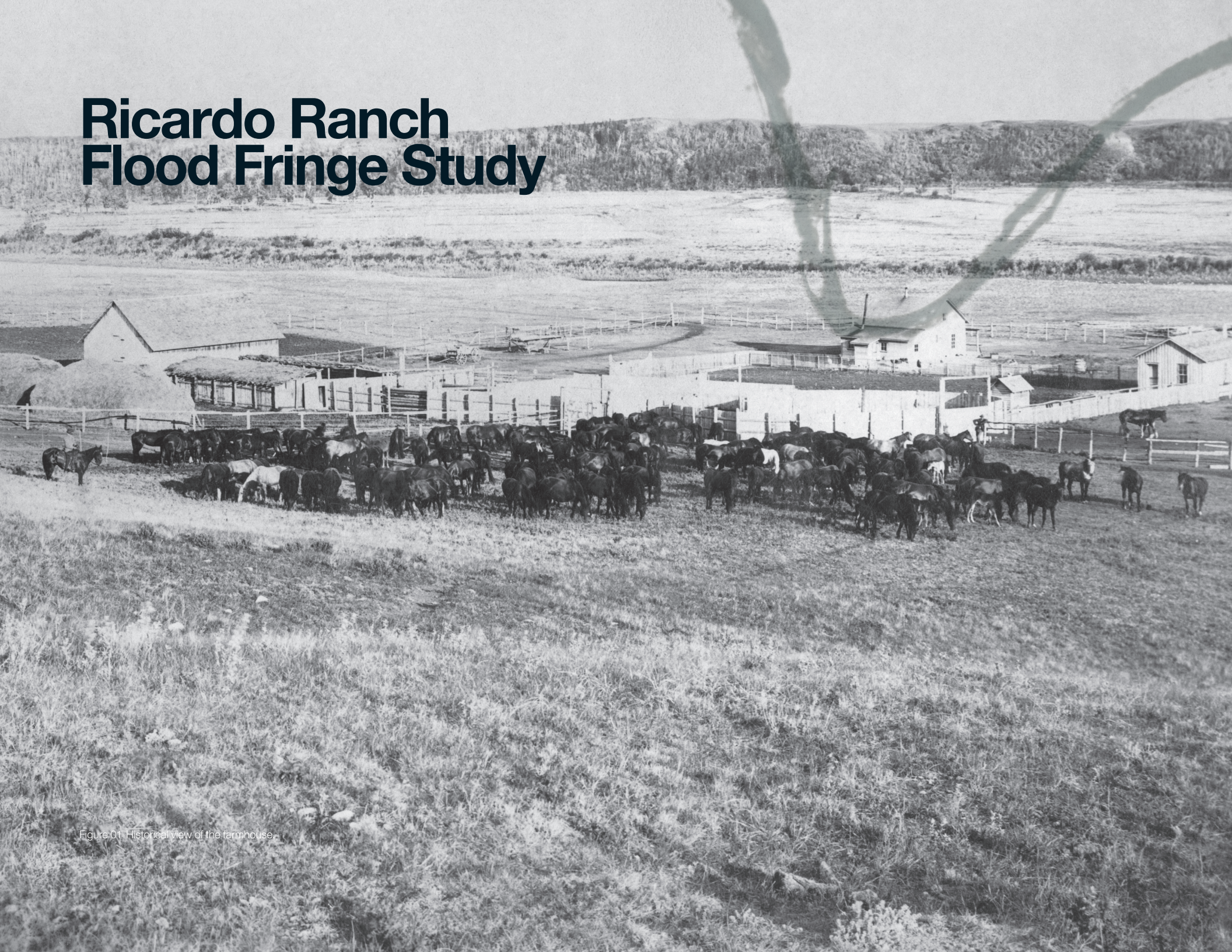


Figure 01. Historical view of the farmhouse.

Executive Summary

Project Overview

Intent:

The Ricardo Ranch Flood Fringe Study was commissioned by The City of Calgary and completed by O2 Planning + Design with Klohn Crippen Berger in 2018-19. The intent of the study was to evaluate a series of land-use scenarios for the Flood Fringe area of a Ricardo Ranch, an upcoming development adjacent to the Bow River in southeast Calgary. The work is meant to contribute to The City's growing understanding of the implications of Flood Fringe development, augmenting several other existing studies and mitigation projects that have occurred since the 2013 floods.

Current Use:

Two distinct regions comprise the Flood Fringe within the Ricardo Ranch Study Area. The region to the east was not considered viable for development, so the study focused on the west region. The west region has been used for agriculture and was also the site of gravel extraction some time before 1955. The boundaries of the Flood Fringe, and therefore the present study, were drawn from the latest maps produced by the Province of Alberta.

Deliverables:

The study team was given two key tasks: (i) develop a range of land-use scenarios, and (ii) assess these scenarios using a Triple Bottom Line (TBL) framework that used economic , social, and environmental indicators.

Engagement:

With the support and input of a City-convened stakeholder Working Group, the study team developed 6 land-use scenarios that were broad, distinct, and viable as potential development futures for the site. In parallel, the same group developed indicators in the three TBL categories, each of which was assigned a desired performance.

Method:

The scenarios were scored according to the degree to which they undermined (-1, -0.5), were neutral to (0), or supported (+0.5, +1) the desired performance of each indicator. The indicators were in turn assigned a weighting to provide different degrees of influence on the overall scenario scores–for example, in the final scoring, the indicator Human Impacts Due to Flooding (10% influence), was given twice the weighting of Business and Tourism Development Impacts (5% influence). The weighting of all indicators used for the final scoring is an aggregation of scores assigned by the project's study team, including the Working Group.

The study team was also asked to include consideration for longer-term impacts like climate change in their modelling and analysis. This took the form of three resilience stress-tests that held the land-use scenarios against more demanding "lower-predictability, higher-consequence" futures for the site:

- change in river morphology (shifts in the expected course of the river),
- climate change (increased severity and incidence of flooding events), and
- change in economy (decreased demand for housing and decreased public spending ability).

Some scenarios were demonstrably more fragile than others under these higher-stress conditions. The resilience tests provided an additional layer of insight regarding the long-term risks inherited by each scenario that were not captured in the current conditions TBL assessment. Each scenario bears additional risks inherited from these tests that should be taken in concert with the TBL findings.

Key Results

Three scenarios were identified as providing the top scores in the TBL:

» Scenario 3—Residential/Natural Park Hybrid (S3)

» Scenario 5—Public Natural/Recreation Park (S5)

		S3	S5	S6
	TBL Analysis	18.5	13.5	7.5
Resilience Test	River Morphology	-24.5	-46.5	-43
	Climate Change	-16.0	-21.5	-19.5
	Economic Decline	2.0	-19.5	-2.5

» Scenario 6—Full Residential Build-Out (S6)

Of these, the highest scoring scenario was Scenario 3 (Natural-Residential Hybrid), comprised of privately-developed residential space set-back from the river by a corridor of light-use public park.

In the environmental domain, Scenario 3 gained points by providing a strip of new high-quality natural habitat along the Bow River corridor that did not invite high-intensity public use. In the social domain, it gained points by creating an attractive natural face for the development, and by providing access to open space amenities for local and regional residents. In the economic domain, it gained points by reducing public costs and by capturing much of the potential land value within and around the study area.

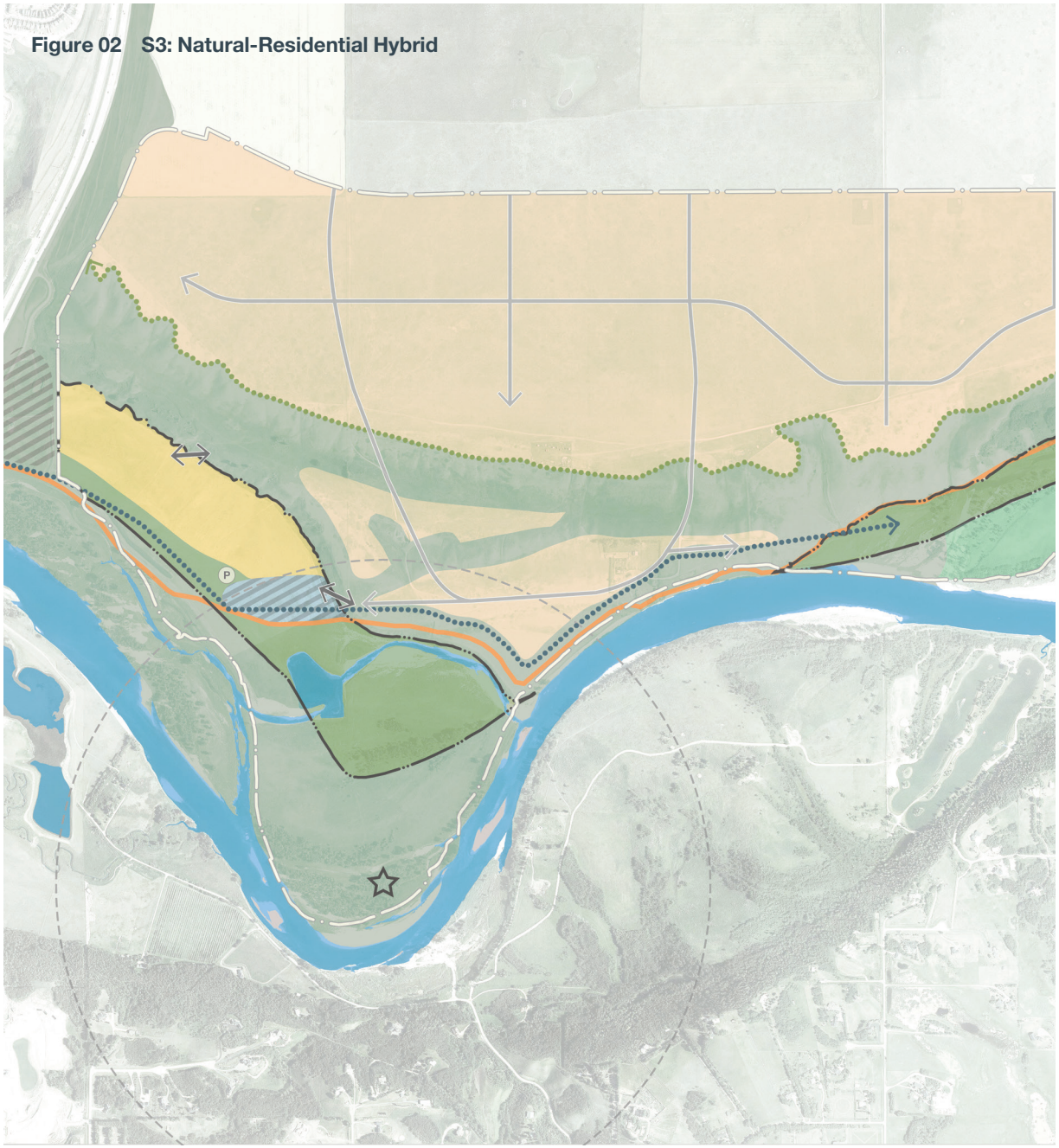
Scenario 3 – Excerpted Detail

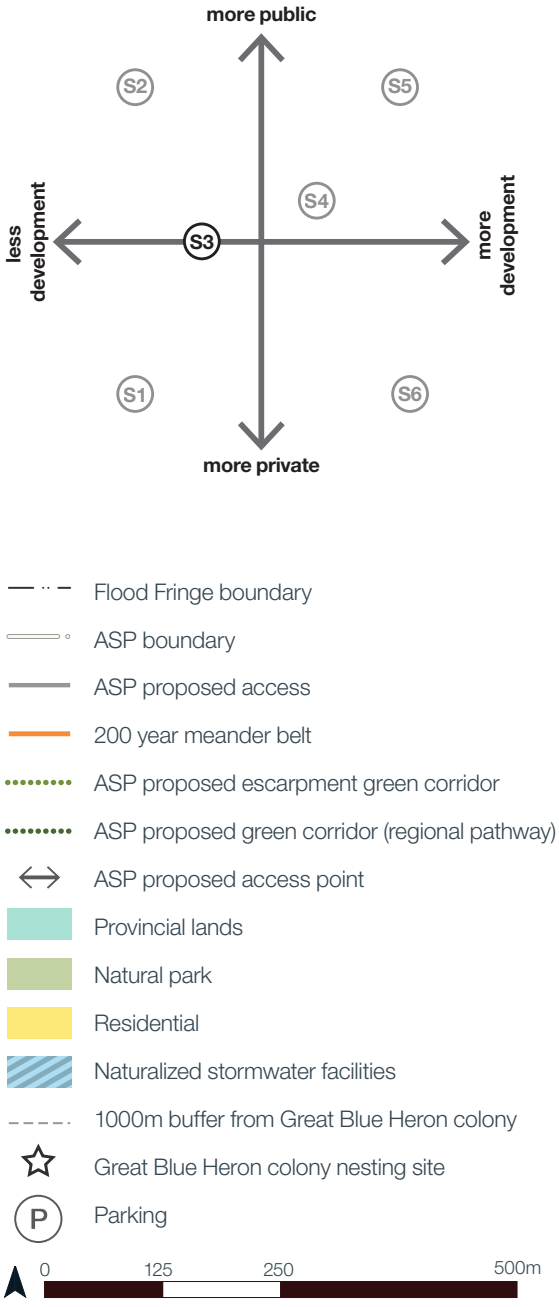
In addition to achieving the overall highest score, Scenario 3 also found the greatest balance between social, economic and environmental performance. Other scenarios that scored well tended to rely more heavily on points gathered from a single particularly strong domain.

Scenario 3 fared relatively well in the resilience tests. In the river morphology test, the natural setback created a helpful mitigating buffer for potential shifts in the expected river course. In the climate change test, Scenario 3 reduced the severity of flooding impacts by stepping development away from the river and reducing the overall residential footprint–though the risk of a catastrophic flooding event remains present and should continue to be a focus of discussion. In the economic decline test, the scenario carried risk with private developers (who could invest in raising and servicing the land but not capture back value) and public risks relating to purchase, construction, and maintenance.

It should be noted that despite its performance in the assessment model, Scenario 3 still bears significant risks that require further consideration. More information on the risks born by this scenario are outlined in the discussion below and in the body of the main report.

Figure 02 S3: Natural-Residential Hybrid





Return Periods and Risk of Flooding to Development

A common theme emerged throughout the course of this study, relating to the way that flood return periods are commonly used to assess risk. Several clarifying statements are included here to build a bridge between technical and common understandings.

» Flood return periods (e.g. 100-year or 200-year flood) do not describe the incidence rate of a particular flooding intensity, but rather the yearly odds that such an event will occur. Instead of understanding a 100-year flood as a flood that tends to happen once per century, one should rather imagine a 100-sided die, where one side indicates a flood of that particular intensity. This die is "rolled" every year.

» It can be a further challenge to find meaning in flood return periods, particularly when the numbers become high (1000-year floods, for example, can feel irrelevant and disconnected from daily life, especially in a city less than 150 years old). In this case, it can be helpful to assess these flood risks over a set period of time. Flood return calculators like the one provided online by the American National Oceanic and Atmospheric Administration are a helpful tool to assist with the sometimes unintuitive probability math. For example, the odds of a 200-year flood occurring in the next 50 years is 22.2%, or higher than 1 in 5. Likewise, the odds of a 1000-year flood occurring in the next 50 years is 4.9%, or nearly 1 in 20.

What does this mean for the present study? In Ricardo Ranch, the current RRASP requirement is that developed land is raised 1m higher than the level of a 1:100 flooding event. Throughout most of the study area, this extra meter beyond the 100-year return is mostly sufficient to clear a 1000-year flood elevation. So what are the odds that a flooding event that exceeds these requirements will occur? Take two time periods: 46 years (the average remaining lifespan of a Calgarian) and 100 years (a reasonable guess at the life-expectancy of the concrete foundations for houses built in the area).

Assuming that a 1500-year event would have catastrophic impacts at Ricardo Ranch, the odds of a catastrophic event occurring…

» …in the remaining life of the average Calgarian is: 3% (1 in 34).

» …in the lifespan of the houses built there is: 6.5% (1 in 16).

Importantly, these calculations are based on conventional projections of flood intensity. Climate change will likely increase the incidence of severe events, requiring even more conservative estimates of risk.

Scenario Assessment

To capture the importance of uncertain future risks, the study adopted an indicator assessment framework to measure the development scenarios against Triple Bottom Line (TBL) indicators and three Dimensions of resilience. The TBL first evaluates the development scenarios based on current conditions and knowledge. The second assessment, the Resilience Test, evaluates longer-term questions of resiliency, and analyzes the scenarios through a lens of "uncertain futures," including dimensions such as climate change, river morphology, and economic decline. This two-stage assessment allows the study to speak to both the known current conditions and shed light on the risks that each scenario may inherit in the future.

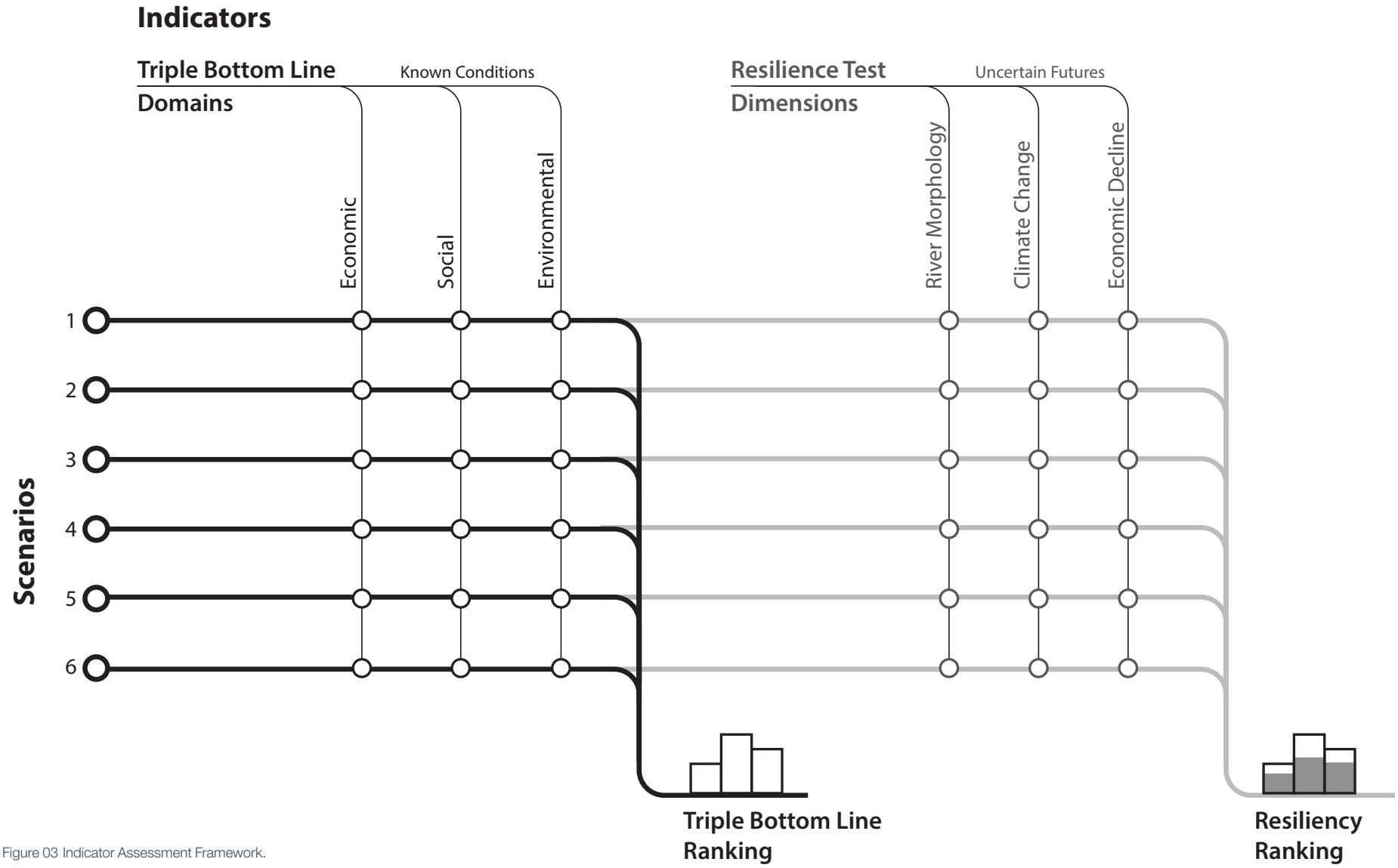


Figure 03 Indicator Assessment Framework.

O2 Ricardo Ranch Flood Fringe Study

Prepared for: The City of Calgary
Prepared By: O2 Planning + Design

1 Introduction

With an undeveloped shoreline stretching nearly seven kilometres, the river valley portion of the Ricardo Ranch Area Structure Plan (ASP) provides a healthy riparian environment within the City of Calgary. Located on the site of a reclaimed former gravel pit, this area is the last significant unplanned and undeveloped flood hazard area in Calgary's city limits, and has been repeatedly recognized as an important reach of the Bow River Valley.

The lands that encompass the study area have been explicitly recognized by Council, who in 2004 approved a Regional policy plan that stated "Portions of the Bow River Valley shall be conserved and protected as a natural park system and appropriately integrated with urban development in recognition of its significance and importance within the Southeast Planning Area". As the ASP is developed, there is a pressing need for a fulsome understanding of the environmental, social, and economic impacts of development in this area. Growth must meet residential, infrastructure, and transportation requirements for the area, minimize flood risks to people and property, and sustain and preserve the long-term natural function of this vital landscape.

There is an opportunity to apply learnings from the 2013 Flood and incorporate new mitigation strategies to enable a resilient, vibrant development.

The Ricardo Ranch Flood Fringe Study enters a complex and shifting context.

The field of watershed management has evolved dramatically in the past 20 years. Research and practice have contributed to deeper knowledge, more consistent measurement, and more accurate modelling and prediction. The lived experience of floods has helped bring light to hidden vulnerabilities and added broad urgency to the subject. On top of this, new understandings of climate change and ecosystem function are adding complexity and compelling further review.

Watershed regulations and urban planning have not matched pace with this change, leaving questions about whether existing policies and practices sufficiently account for the latest understanding of risk and opportunity present in watershed development.

This study situates itself within a larger body of work, tasked with bridging the gap between conventional planning practice and the emerging imperatives of good watershed management.

Figure 04 View south of the anthropogenic pond from the second bench

1.1 Purpose and Methodology

The City-led Ricardo Ranch Flood Fringe Study provides a framework to define a range of Flood Fringe development possibilities for the area, assesses the explicit trade-offs of these possibilities, establishes appropriate spatial limits to development, and executes a two-stage indicator assessment framework to arrive at recommended potential development scenarios for the Flood Fringe. This indicator framework consists of an initial Triple Bottom Line (TBL) assessment and a secondary resilience test. Together these assessments highlight development scenarios that balance environmental, economic, and social outcomes, and call attention to their associated inherited risks from the uncertainties of climate change, river morphology, and economic decline.

This intent of this study is to inform future development decisions in the Ricardo Ranch Flood Fringe area and start the discussion of risk mitigation, priorities and development objectives for the area. This study will highlight three potential development scenarios that score the highest according to the two-stage indicator framework developed for this study, and will draw attention to the risks the scenarios inherit in uncertain and changing future conditions. These scenarios and the results of this study are intended to inform future land use planning and decision making.

1.2 Project Timeline

The Ricardo Ranch Flood Fringe Study began in the spring of 2019, to be completed in three main phases by the fall of 2019. An inclusive working group comprised of City staff, landowners, subject matter experts, and community and civic stakeholders collaborated to ensure that the project team considered all pertinent factors during the creation of the development scenarios and their evaluations. Over the course of the study, the working group met four times to provide their input into the progress of the study and provide direction for the project team.

Figure 05 Project Timeline

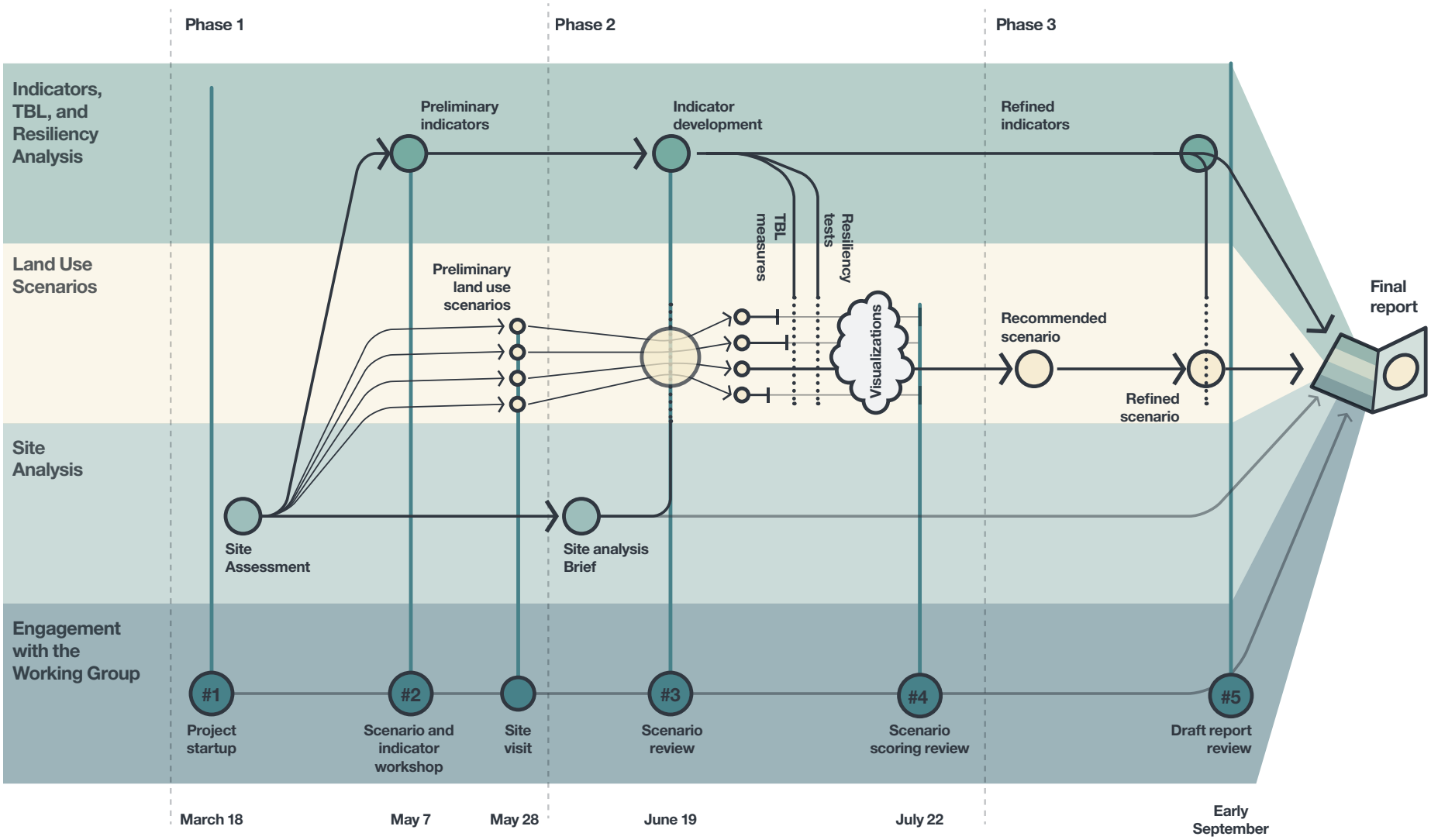


Figure 06 Western Flood Fringe study area is highlighted.

1.3 Report Structure

I Introduction:

Introduces and outlines the purpose of the study.

II Site Analysis:

Analyzes current site conditions to gain a better understanding of the opportunities and constraints of the Ricardo Ranch Flood Fringe Study area.

III Land Use Palette:

Describes high level land uses that the project team determined suitable for the site and chose to use for the creation of the potential Flood Fringe development scenarios.

IV Flood Fringe Development Scenarios:

Briefly explains the process of creating the six Flood Fringe development scenarios and the conditions that remain constant between each scenario.

V Scoring:

Discusses the methodology for evaluating the potential Flood Fringe development scenarios; a two-stage indicator framework that includes a Triple Bottom Line assessment and a Resilience test.

VI Analysis:

Describes each of the six potential Flood Fringe development scenarios and their associated scoring results.

VII Conclusion:

Discusses the scoring results of the top 3 potential Flood Fringe development scenarios, their associated risks, and the conclusions that can be drawn from the Ricardo Ranch Flood Fringe Study.

Figure 07. Panoramic view of the Eastern Study area looking south-southeast.

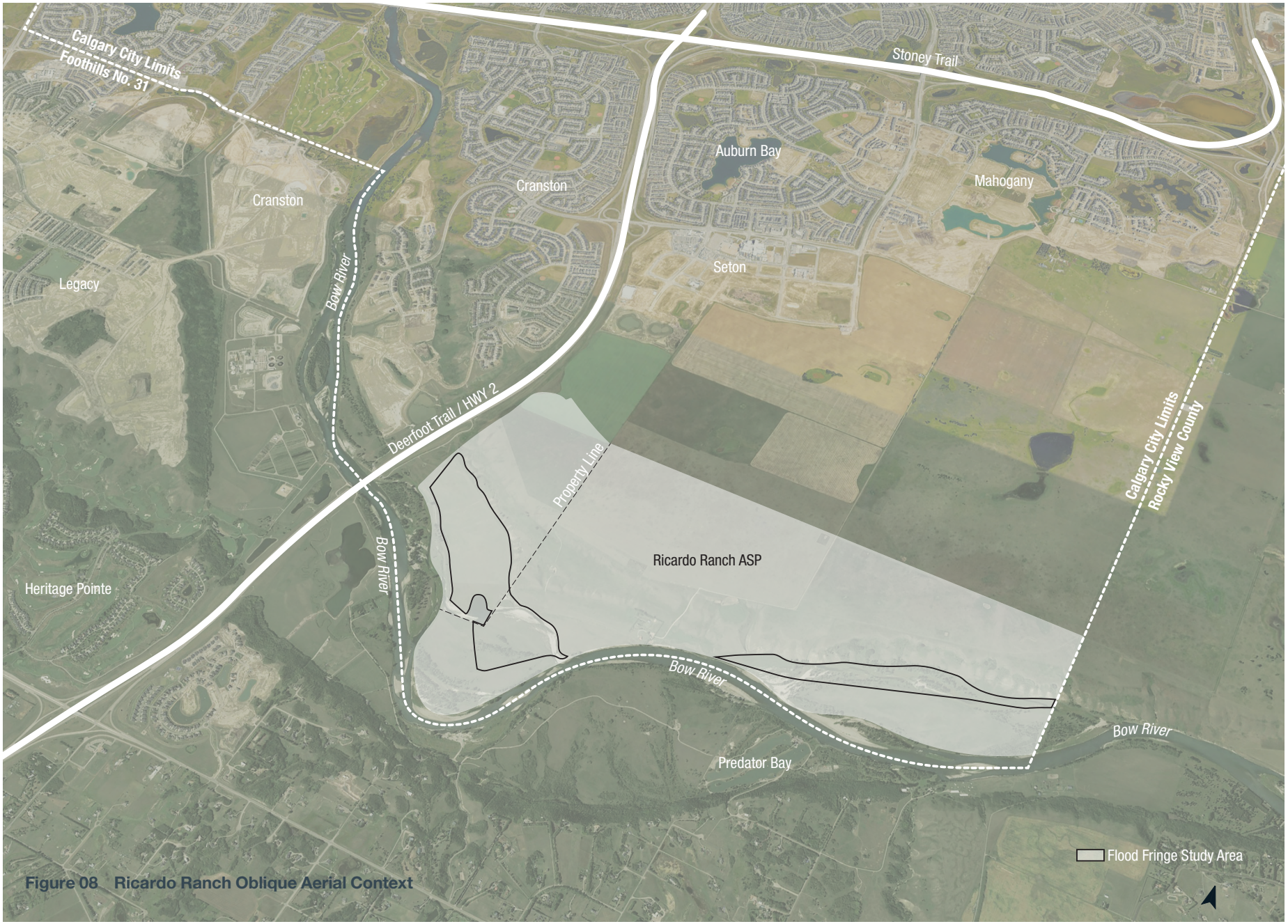


Figure 08 Ricardo Ranch Oblique Aerial Context

2 Site Analysis

2.1 Site Context

The Ricardo Ranch Study Area (the Study Area) is located at the southeast tip of The City of Calgary, east of Deerfoot Trail, and south of the South Health Campus. The Flood Fringe areas occupy the bulk of Neighbourhood 4 as outlined in the ASP. Neighbourhood 4 also includes the valley slopes and the flat bench areas above the Flood Fringe lands.

The Study Area is located in a transition area between the Foothills Fescue Natural Subregion and the Foothills Parkland Natural Subregion. Terrain in the Study Area consists of flat to undulating topography in the northern portion of the Study Area and includes the Bow River valley, escarpment, Floodway, Flood Fringe, and associated river meander belt. The Bow River valley itself has regional significance, as it acts as a natural wildlife corridor and provides opportunities for recreational activities. Environmentally Significant Areas (ESAs) in the Study Area include the escarpment, wetlands, drainages, channels, Flood Fringe, glacial features and wildlife habitat, which are identified in the Ricardo Ranch ASP.

The Ricardo Ranch ASP area is located downstream from Fish Creek Provincial Park, the Pine Creek Wastewater Facility, and The City's Pine Creek treenursery. The nearest completed residential community within city limits is Cranston, located west of Deerfoot Trail. Across the river in Foothills County, developments include the Province's Policeman's Flats river access point (planned for closure in coming years), and the Predator Bay waterskiing club.

The high quality trout habitat found in this reach of the Bow River has made this area a world-renowned trout fishing destination. While river recreation within the city has historically been concentrated in the Bearspaw Dam to Calgary Zoo reach, the recent completion of the Harvie Passage weir bypass makes within-city river rafting more viable to the Ricardo Ranch ASP lands. Currently, the river is accessed from Policeman's Flats with fishing effort concentrated downstream. The planned closure of the Policeman's Flats access point and likely increased use of the Bow River by city and regional residents make the provision of river access within the Study Area a priority.

Figure 09 Panoramic view of the Western Study area looking south-southwest towards Deerfoot trail.

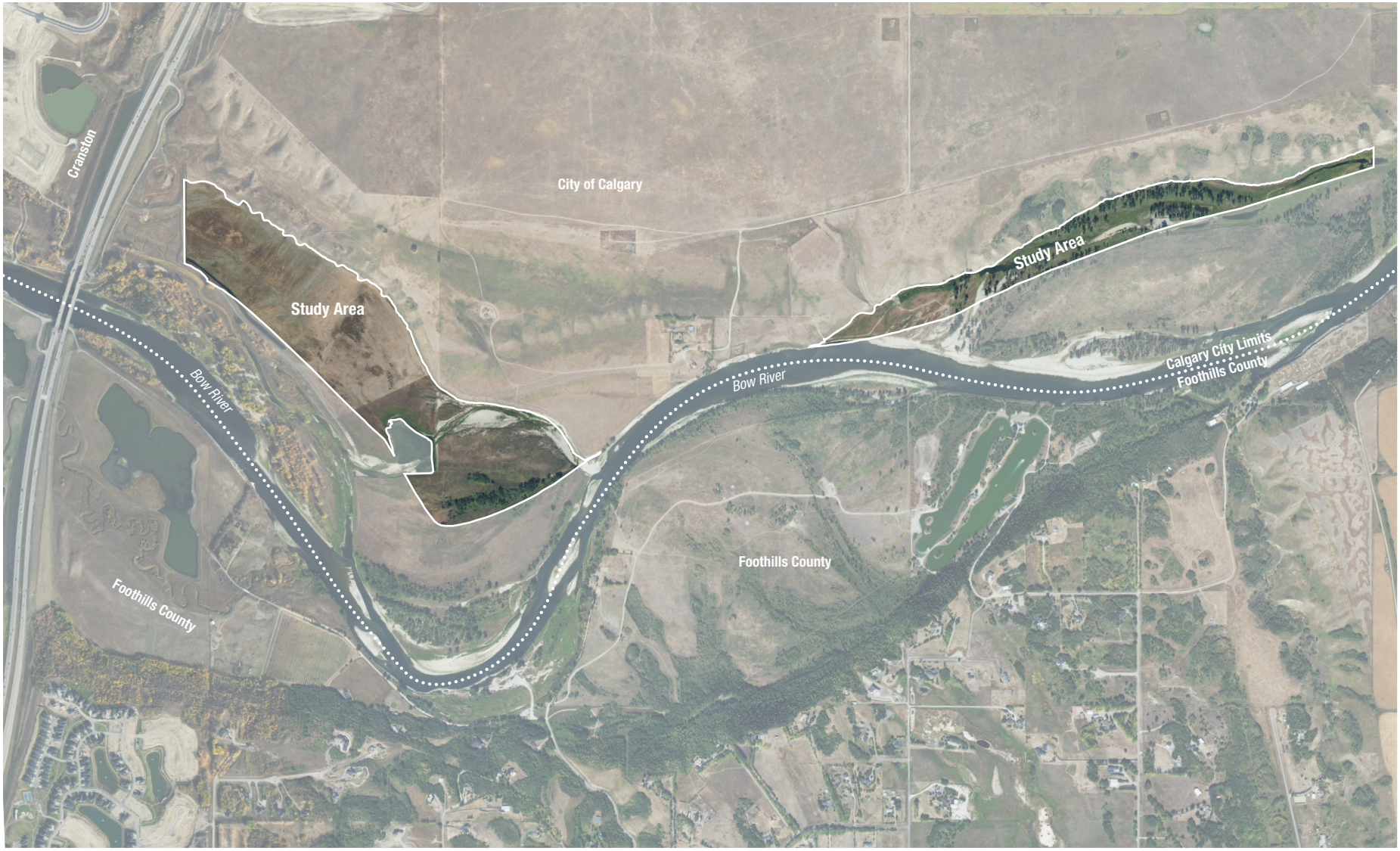


Figure 10 Aerial Imagery

Figure 11 2013 Flood, Aerial Imagery

Current regulatory Flood Fringe in the Ricard Ranch study area and immediate vicinity within City limits.

This image indicates the extent of flood impacts to the Flood Fringe during the 2013 Flood event.

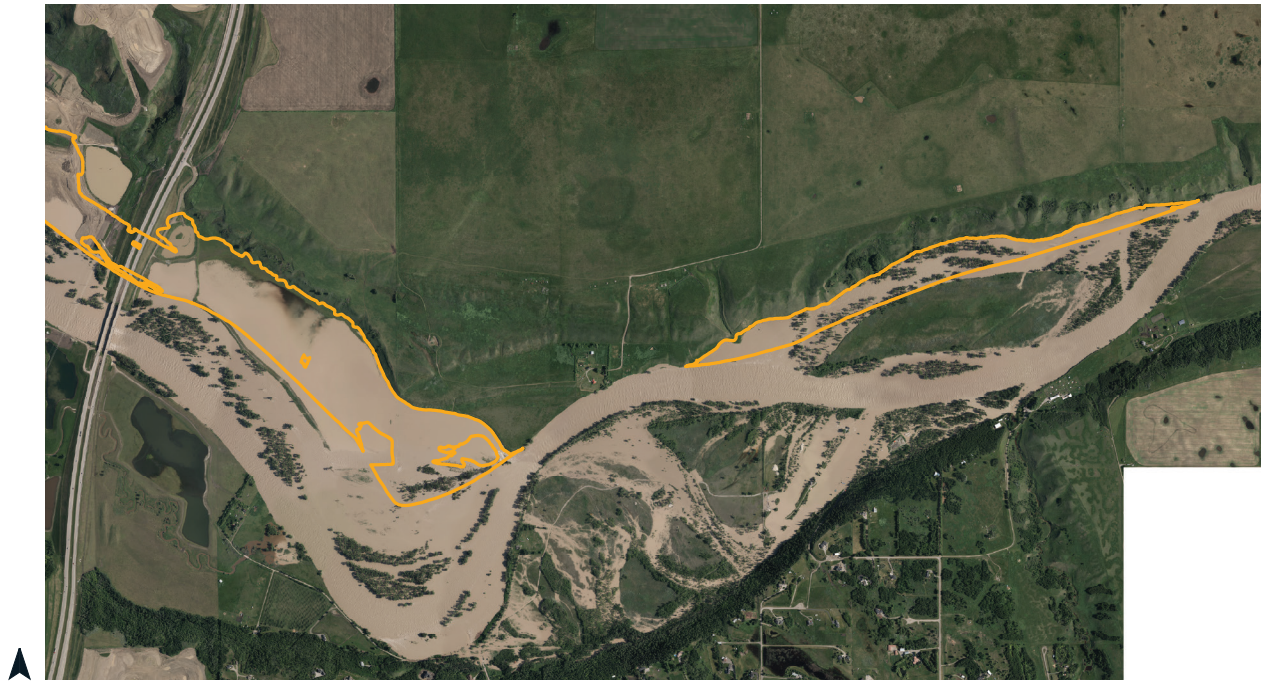
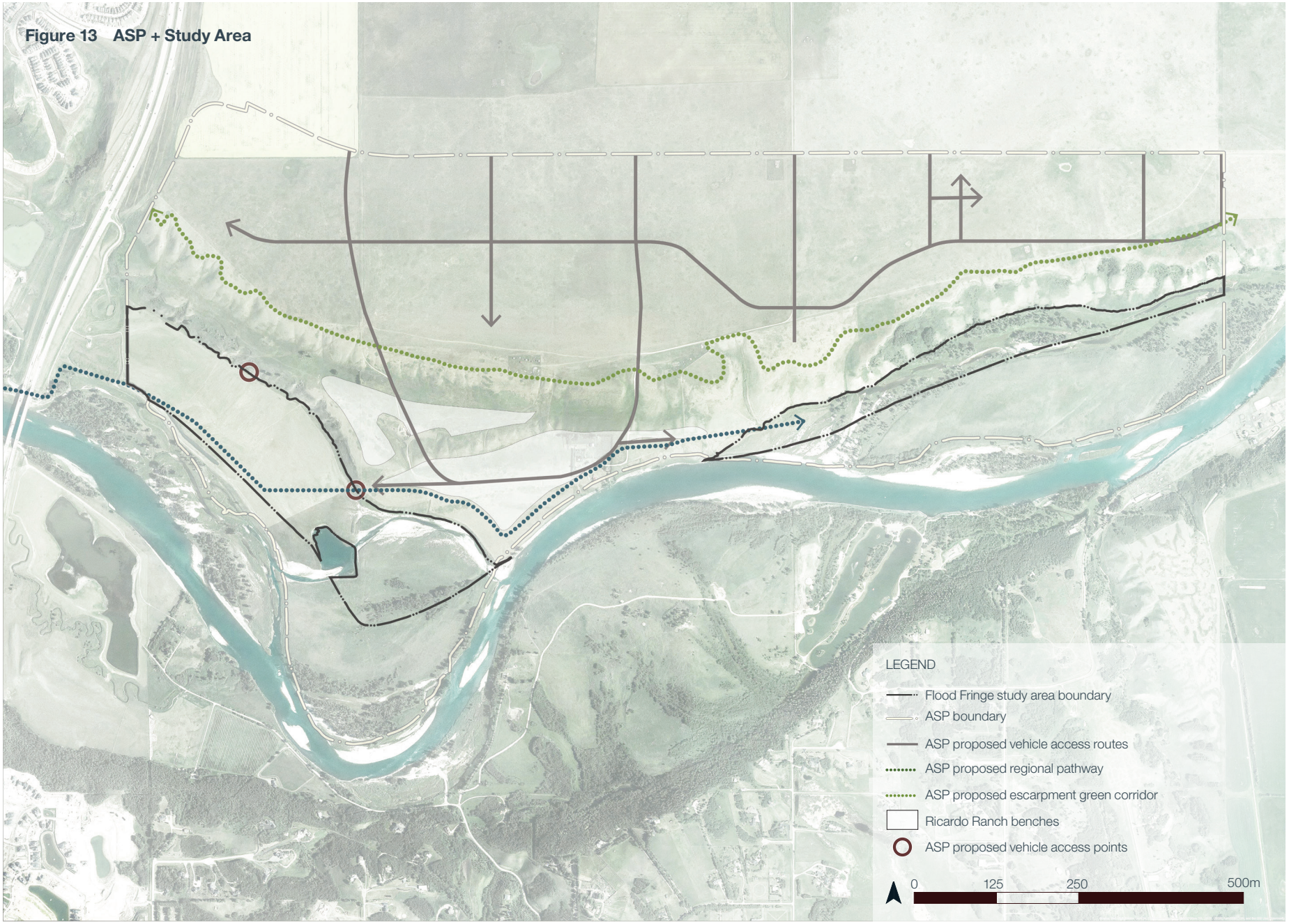


Figure 12 View of the eastern study area riverbank.

Figure 13 ASP + Study Area



2.2 Site Description

The Study Area comprises the designated Flood Fringe area of the Ricardo Ranch ASP, situated on the traditional territories of the people of the Treaty 7 Region which includes the Blackfoot Confederacy (comprising the Siksika, Piikani, and Kainai First Nations), the Tsuut'ina First Nation, the Stoney Nakoda peoples (comprising the Chiniki, Bearspaw, and Wesley First Nations), and is also home to Métis Nation of Alberta, Region 3. The current land use of the area is pasture land for livestock with farm buildings located on the top of bank and on the eastern portion of a flat bench above the Flood Fringe area.

Two flatter benches of land located downslope from the top of the river valley escarpment separate the study area into two disconnected areas: a smaller eastern section of 21.9 ha and a larger western section covering 51.5 ha. Adjacent to the forested riparian area bordering the Bow River, the smaller, relatively undisturbed eastern portion is narrower and has had little historical development. The western portion was the site of a reclaimed gravel mine, which has since been reclaimed and is now dominated by pasture grasslands, interspersed with various natural wetlands. A steep berm denotes the southern boundary of this western section.

Road access connects to the existing homestead and farmland, with only cattle trails providing access to the western section of the Flood Fringe area. Deerfoot Trail lies further west of the study area; however, public road access is not available.

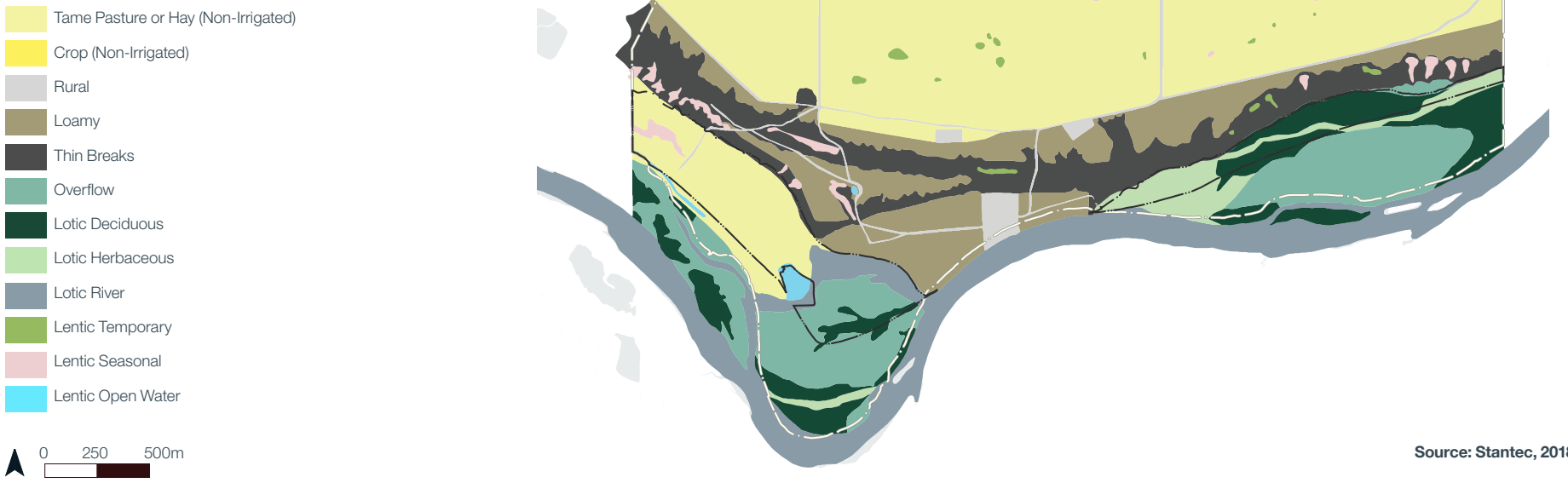
2.2.1 Land Cover

The eastern section of the Study Area is dominated by deciduous riparian cottonwood stands and herbaceous shrubland, with slumping soil breaks on the slopes above. A gravel bar cuts inward toward depressions containing standing water.

The western section is dominated by tame pasture, with a large man-made open water pond (also known as the dug-out) located in the southeastern portion of the section, giving way to shrub and riparian vegetation to the east. The lower slopes of this area contain groundwater seeps and notable unstable slopes showing signs of slumping.

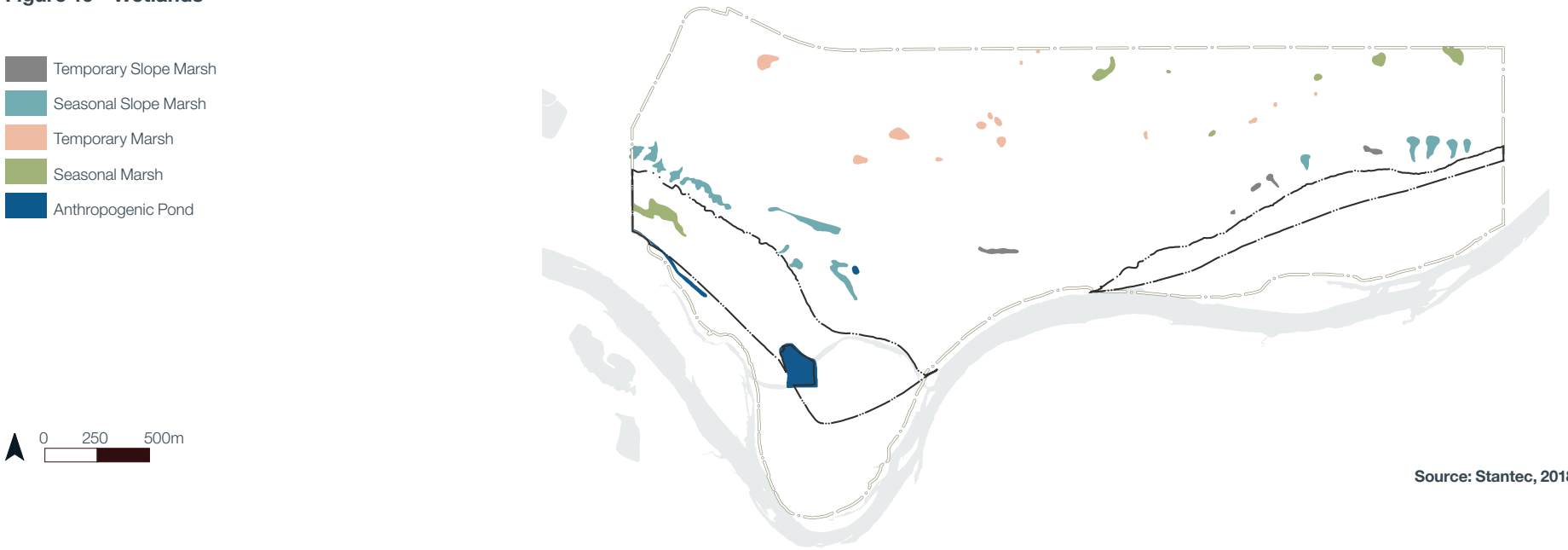
Figure 14 The dug-out in the western section, view from the upper bench, looking south toward the lower bench and the Bow River.

Figure 15 Land Cover



Source: Stantec, 2018

Figure 16 Wetlands



Source: Stantec, 2018

Figure 17 A man-made open water slough runs the length of the berm in the western section.

Figure 18 Pockets of temporary wetlands are interspersed with more common pasture land and non-native vegetation.

2.2.2 Wetlands

A seasonal marsh is located close to the western boundary of the western Flood Fringe section, and evidence of wetland vegetation has been noted throughout the pasture-dominated area. A linear, artificially-made open water slough runs along the length of the berm towards the larger open water pond to the southeast. While artificially, this pond is in good condition with emergent wetland vegetation along the north side, and a hydrologic connection to the Bow River. The slopes above both sections contain numerous examples of temporary and seasonal slope marshes and springs.

2.2.3 Floodway

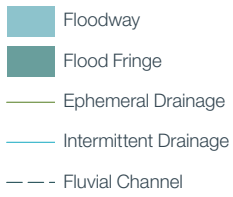
The Bow River Floodway covers substantial lands bordering the study area, in both the east and west sections. The benches, which subdivide the Flood Fringe area, are the exception to this where the Floodway narrows and becomes impassable.

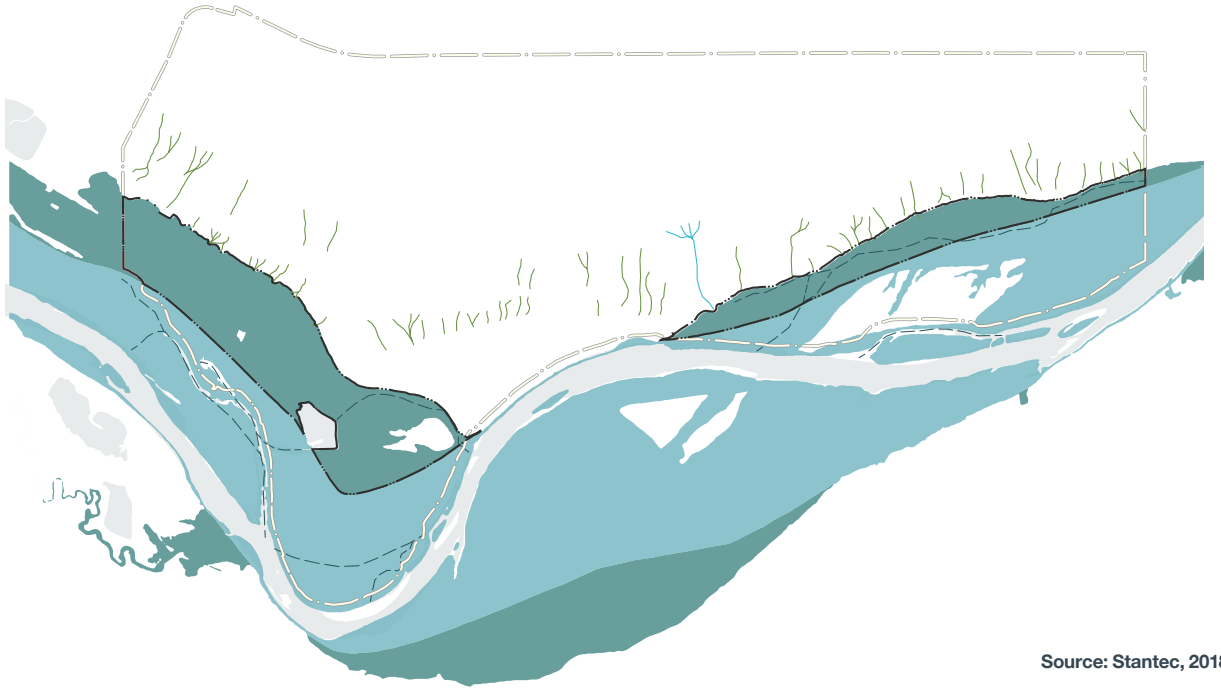
During the 2013 flood, floodwaters rose to cover all but the highest points of land within the Flood Fringe (Figure 11). During this time, a new channel began to form below the benches between the man-made pond and the slopes. While this has not been formally claimed as the river by the Province (Appendix B), the long and term river channel erosion projections will see the river meander through this channel.

2.2.4 Slopes

While the steepest slopes in the area are not located adjacent to the Flood Fringe sections, they are a common feature. In general, slopes above the western section are initially gentler, and increase in slope and instability below the benches. Slopes in the eastern section are both longer and steeper, with fewer breaks. Ephemeral and intermittent drainage channels are found along the slopes in both sections.

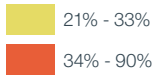
Figure 19 Water Resources

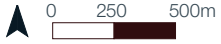


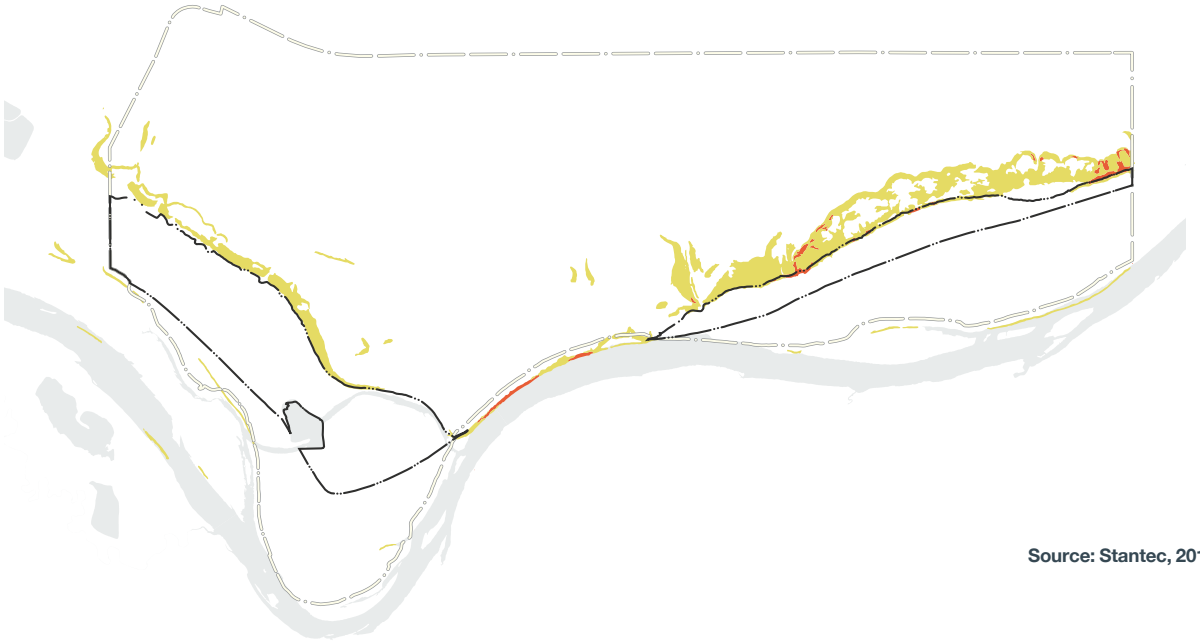


Source: Stantec, 2018

Figure 20 Slopes







Source: Stantec, 2018

Figure 21 Environmental Significance

Low
Moderate
High

0 250 500m

Source: Stantec, 2018

Figure 22 Wildlife Observations

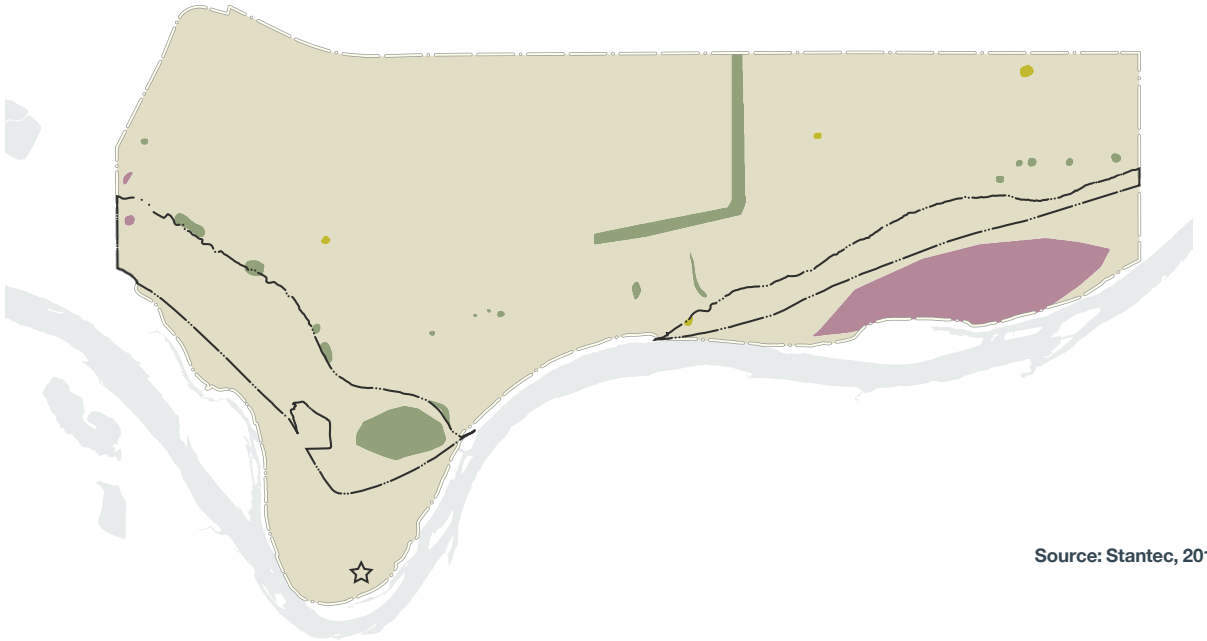
Approximate Tracked and Watched Species Density

0 - Trace per 100 m
5 - 9 Individuals per 100 m
10 - 49 Individuals per 100 m
50 - 100 Individuals per 100 m
Heron Nesting Site

Mapped observations are from the following surveys:

- Winter track count
- Nocturnal forest owl survey
- Amphibian survey
- Snake hibernaculum survey
- Rail survey
- Bird survey
- Tree-nesting raptor and great Blue Heron survey
- Acoustic bat survey

0 250 500m



Source: Stantec, 2018

2.2.5 Environmental Significance

The Province's Environmentally Significant Areas assessment (2014 update) identifies the entirety of the eastern section as 'High Significance'. The eastern portion of the western Flood Fringe section and the slopes above the Flood Fringe are also identified as having high environmental significance. An area directly west of the farm has been given a 'Moderate Significance' rating (Figure 21).

2.2.6 Wildlife Observations

An aggregation of wildlife surveys (Stantec, 2018) and confirmed through site visits, highlights the eastern Floodway section as a key hotspot of biodiversity in this area. Connectivity into these lands is important to maintain. Hotspots with somewhat lower species density are located in western section, east of the man-made pond, and in the slope depressions associated with springs and temporary slope marshes. A Blue Heron nesting colony is located on the peninsula south of the man-made pond in the riparian forest within the Floodway.

2.3 Key Constraints

Unique constraints to development in the study area are outlined in the Ricardo Ranch ASP, chiefly that of the Floodway, Flood Fringe, 200 year meander belt, and the need for mitigation of any development or human activity within 1000m of the Blue Heron nesting colony. Natural drainage courses within the area should be preserved as per the Ricardo Ranch Master Drainage Plan, following the recommendations made in the Ricard Ranch ASP and Municipal Development Plan (MDP).

The ASP specifies that lands in the Bow River valley that qualify as Environmental Reserve (ER) such as slopes, ravines, coulees, waterbodies and wetlands shall be dedicated as ER. The existing topography of the Bow River valley escarpment should be maintained. Should development occur within and along the escarpment, all development should adhere to the Slope Adaptive Development Guidelines Policy and Conservation Planning and Design Policy.

Within this study, the project team was given direction to use '1m above the 1:100 flood elevation' as a functional shorthand to calculate the minimum elevation for main-floor development. While not found directly in policy, this equation produces a workable estimate that accounts for the much more complex requirements embedded in bylaw.

Figure 23 Looking from the top of the berm into the riparian lands of the Floodway in the western section of the study area.

2.3.1 Water-Based Constraints

The majority of the Flood Fringe study area is covered by the 1 in 20 year flood inundation estimate, which covers the entirety of the eastern section up to the slope edge, and stops between 7 and 20 m short of the slope edge of the western section. The 1 in 100 and 1 in 200 year inundation areas cover increasingly more of the western section, stopping only at the elevated rise of land east of the man-made pond. These estimates highlight the elevated flood risk in these areas. A sampling of locations within the study area conducted by Klohn Crippen Berger shows that existing elevation of the western section varies between 980 - 983 m. The 1:100 year flood has an elevation range between 983.86 - 986.76 m, requiring 5 metres of fill material to raise the potentially developed area to a height of 985 - 988 m, with the highest elevation located in the furthest upstream areas in the far west.

The 200 year meander belt covers the southeastern third of the western section, and all of the eastern section. The meander belt identifies the area of the valley that may reasonably be occupied by the Bow River in the long term (200 years) due to river morphology projections. Within this study, the project team was given direction to ensure that building footprints and permanent structures were not to be located within this extent due to the increased flood risk and subsequent riverbank erosion within the meander belt.

The artificially-made open water pond has a hydrologic connection to the Bow River. Its removal or modification would require extensive geotechnical considerations and would require Provincial approval.

2.3.2 Terrestrial Constraints

In accordance with Provincial guidelines, a setback distance of 1000 metres is recommended from the existing Great Blue Heron nesting colony. If development is proposed within 1000 metres of the rookery, the applicant shall provide a longterm vegetation disturbance mitigation plan as a component of a Biophysical Impact Assessment (BIA) to determine strategies to minimize disruption to the colony.

Seeps along the slopes have led to the development of slope marshes characterized by riparian vegetation and aspen stands in depressions along the slope edge.

Figure 24 Looking from the top of the berm into the riparian lands of the Floodway in the western section of the study area.

Figure 25 Looking to the southeast down into the Flood Fringe area of the western section from the top of bank.

Figure 26 Water-Based Constraints

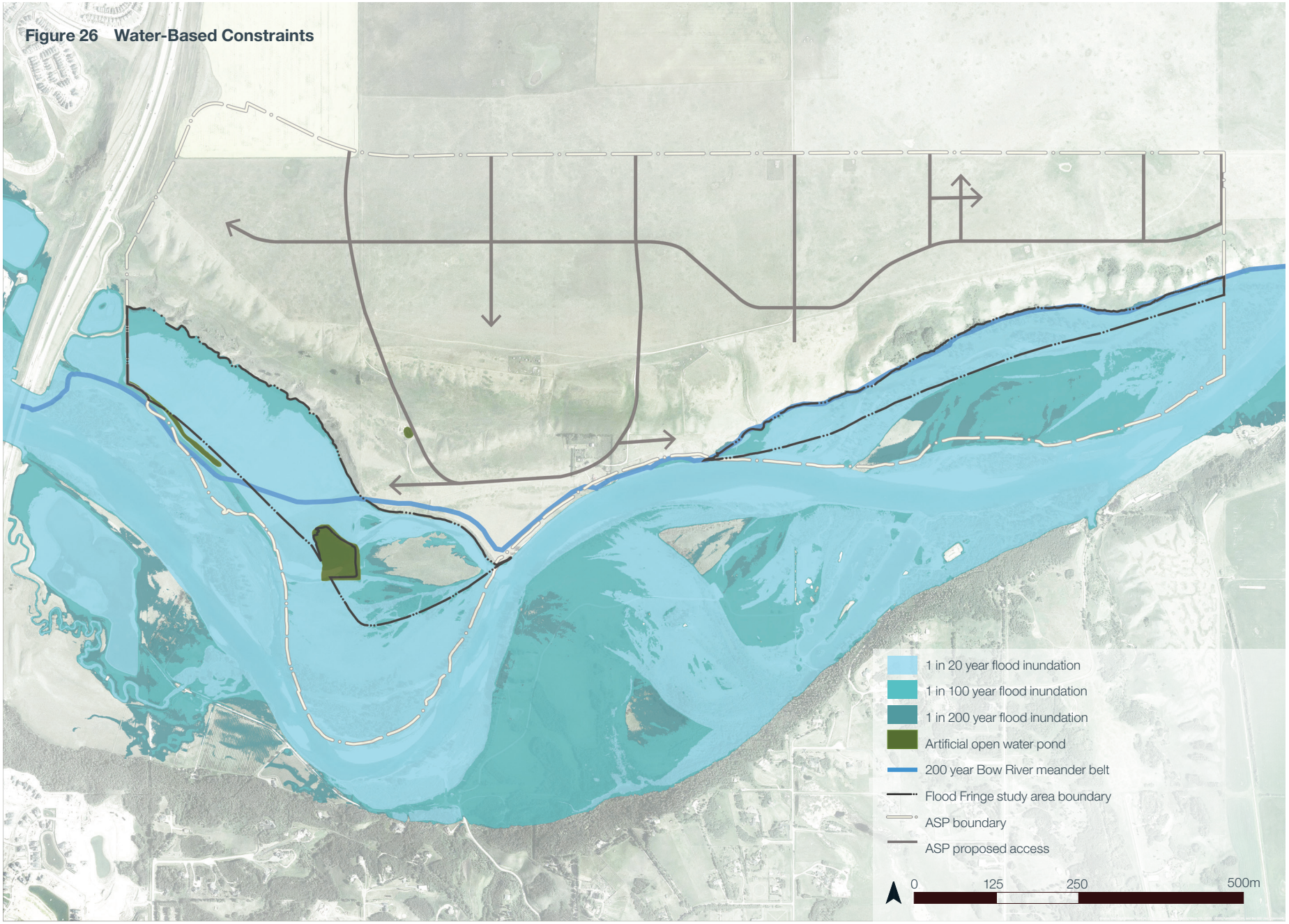


Figure 27 Terrestrial Constraints

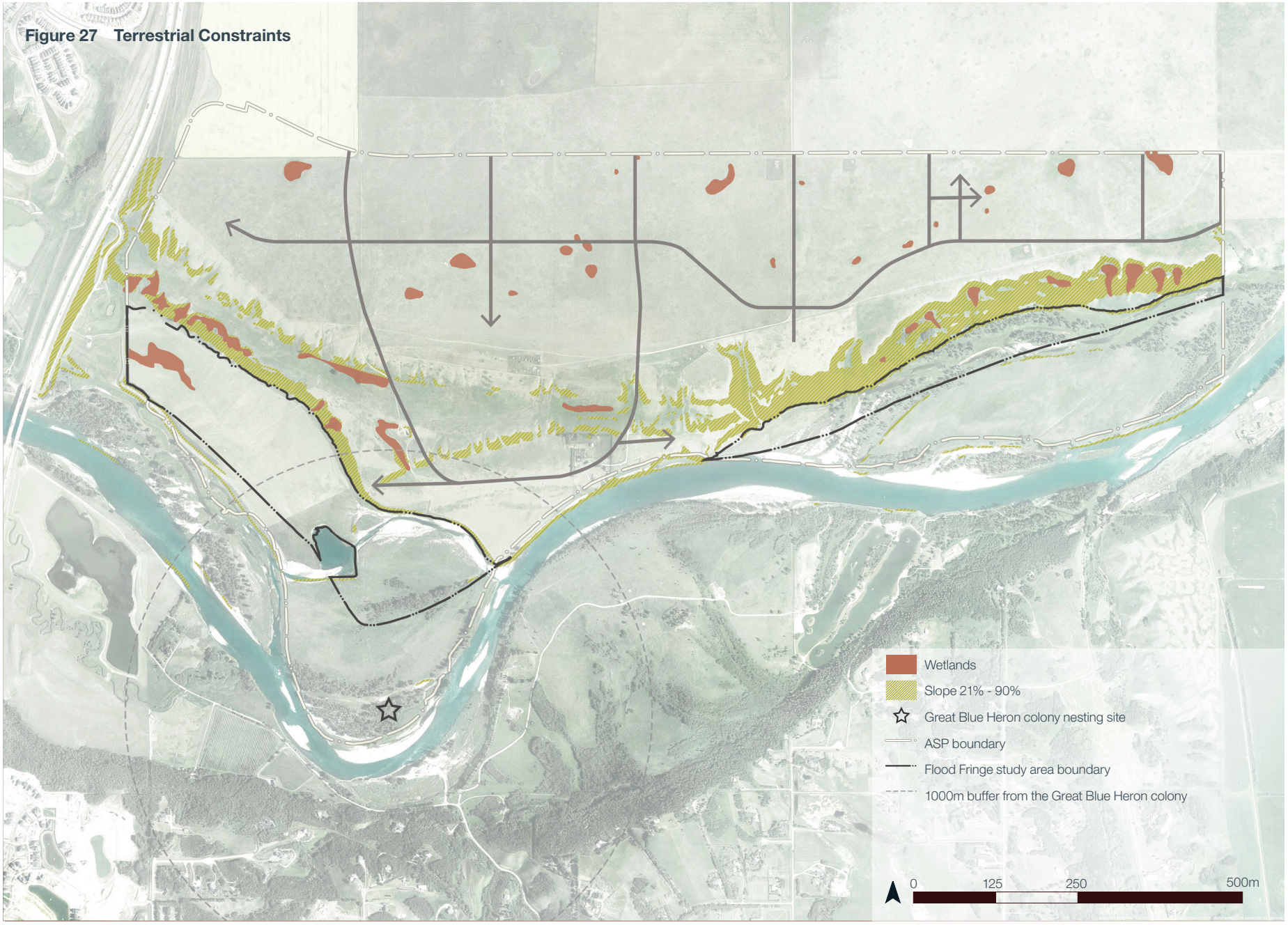


Figure 28 Project Team during a site visit, looking from the top of the bench towards the west-southwest.

3 Land Use Palette

To begin creating the Ricardo Ranch Flood Fringe development scenarios, the Project Team first put together the land use palette. The land use palette is a high-level selection of five different land uses, and an amenity node, each of which are described in more detail below. These uses were determined to be suitable for the Ricardo Ranch location and enable the establishment of development scenarios that were differentiating enough from each other to conduct a meaningful analysis.

3.1 Residential

The residential land use is characterized by low-density residential development, including single-family home housing types. Located sensitively throughout this there is the potential for small scale commercial uses, including small-scale cafés, restaurants, or retail. The commercial activity will provide their own parking, however no additional public parking (outside of street parking) is assumed within this land use. The intent is to establish a residential neighbourhood in Ricardo Ranch, (Figure 29).

For the purpose of this study, residential land use requires flood protection up to a 1m freeboard above the 1:100 year flood event. Therefore, this land use assumes the use of 5 metres of fill to lift the area into a place that meets this protection requirement.

3.2 Natural Park

A natural park is a naturalized area comprised of native vegetation that restores the natural health of the Flood Fringe and exists with minimal human maintenance. The natural park emphasizes the establishment of functional and permissive wildlife corridors and habitats within a balanced riparian ecosystem. The addition of new riparian vegetation will naturally improve this land uses resiliency to the negative impacts of future flood events.

This land use assumes no public road access, with the only public access provided via an extensive trail network, including the planned Regional Pathway. The natural park provides the user with a restorative natural experience, and lends itself to recreational activities such as walking, cycling, and observing nature. This use is likened to that found in Weaselhead Flats or Griffith Woods, Calgary, AB. (Figure 30). This land use assumes minimal fill required, varying only for grading purposes.

Figure 29 Low density, residential land use.

Figure 30 Natural park land use. E.g. Weaselhead Flats or Griffith Woods, Calgary AB.

3.3 Recreation Park

A recreation park is a naturalized area, comprised of native vegetation and areas designated for recreational activities. This may include designated picnic or day-use areas, playgrounds, grass fields or open spaces for informal sports and/or games, and off-leash dog parks. Additional uses may include small-scale commercial such as cafés, restaurants, and/or retail. Recreation park areas may provide both vehicular and trail access. This land use encourages a healthy, outdoor lifestyle within the Flood Fringe. The character of this use is similar to that found at Edworthy Park or Sandy Beach, Calgary, AB (Figure 31).

Areas with this land use are assumed to require 3-5m of fill to provide adequate flood event protection and positive drainage.

3.4 Naturalized Stormwater Facilities

Naturalized stormwater facilities are designed to function and appear as a naturally occurring wetland. Native vegetation provides habitat for wildlife and performs natural ecological functions. The facility is multifunctional, performing a necessary ecological function as well as a natural amenity for both residents and visitors alike.

The naturalized stormwater facility is assumed to be designed to 4 hectares in size and will require 3m of fill to ensure positive drainage, (Figure 32).

Figure 31 Recreation Park land use. E.g. Sandy Beach, Calgary AB.

Figure 32 Naturalized Stormwater Facilities land use. E.g. Dale Hodges Park, Calgary, AB.

3.5 Post-Industrial / Agriculture

This land use captures the intent of leaving the site in it's current condition as a reclaimed gravel pit and current agricultural and pasture land, (Figure 33).

3.6 Amenity Node

The amenity node provides an opportunity for the collection of multiple small-scale commercial uses and potentially higher-intensity recreational uses such as equipment rental (boats, bikes, and/or cross-country skiing), within a development scenario. The node concentrates these uses within a specific location, establishing a central hub of activity the scenario can develop around.

Figure 33 Post-Industrial / Agriculture Land Use. Existing condition.

3.7 Working Group Input

The working group participated in the process of selecting the land use palette during the second working group meeting.

Working Group 2: Palette of Uses

The working group was presented with a set of potential uses that could comprise future development scenarios on the Flood Fringe site. The task was to narrow the potential uses to those deemed most viable and appropriate for the site, to be included in a working land use palette. Attendees were encouraged to keep, modify, and/or disregard the uses provided, as well as create additional uses. This exercise provided the Project Team with valuable insight into what types of land uses, and/or programs the land use palette should contain moving forward.

For the full summary of the Working Group 2, see “Appendix A: Working Group Summaries”.

Figure 34 Palette of uses cards being used in WG2.

Figure 35 Palette of uses cards being used in WG2.

Figure 36 View of the lower bench escarpment, looking southwest.

4 Flood Fringe Development Scenarios

Six potential Flood Fringe development scenarios were created from the refined land use palette. These scenarios were to:

- Capture a broad range of development opportunities for the site;
- Be distinct enough from each other to provide meaningful feedback in the scenario evaluation; and
- Be viable as potential development futures for the site.

From these scenarios, the Ricardo Ranch Flood Fringe Study will highlight the top three that the scoring framework determined as the highest scoring scenarios when considering environmental, economic, and social outcomes. As illustrated in Figure 37, the six scenarios (S1 to S6) capture a range of objectives in terms of development intensity and level of access. This ensures that the scenarios provide an unbiased range of possibilities for the Ricardo Ranch Flood Fringe site and strengthen the validity of the analysis and recommendations.

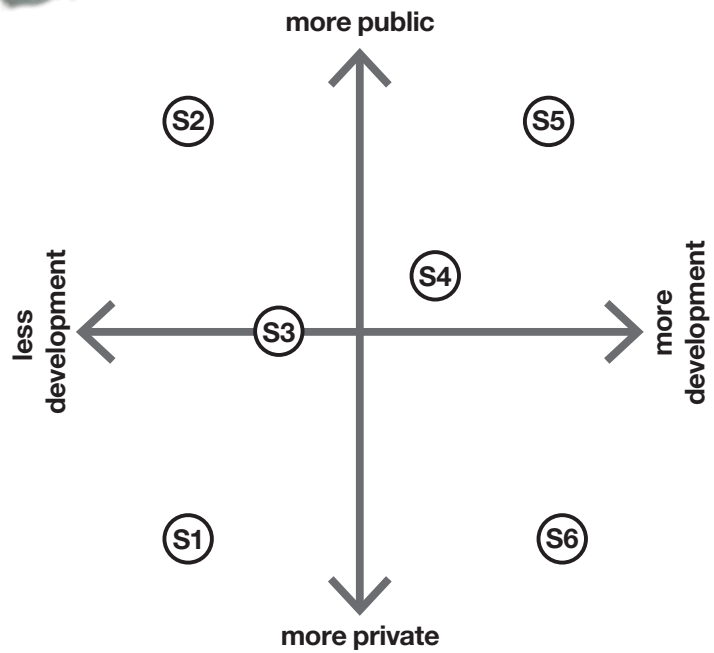


Figure 37 Flood fringe development scenario grid, showcases the intent and intensity of each of the six scenarios.

Flood Fringe Development Scenario Constants

The scenarios differ from each other, however there are considerations that remain constant between the six scenarios. These considerations were derived from the ASP, existing City and Provincial policy regulations, and the site analysis. They include:

- The location of ASP proposed access route and points;
- The location of ASP proposed escarpment corridor route;
- The location of ASP proposed green corridor route (Regional Pathway);
- Provincial Lands location;
- The natural park designation for the east Flood Fringe study area, due to its environmental significance and biodiversity hotspots;
- Consideration of the 1000m buffer from the Great Blue Heron colony, and/or inclusion of impact mitigation efforts;
- The route of the 200 year meander belt, and requirement of all development to be outside of this significant measure; and
- The requirement of a 4 hectare stormwater facility located outside (north) of the 200 year meander belt.
- All development 1m above the 1:100 year flood level.

4.1 Working Group Input

The working group participated in the process of refining the development scenarios through the third working group meeting.

Working Group 3: Scenario Review

The intent of the third working group meeting was to gather thoughts and comments about the high level potential Flood Fringe development scenarios put forth by the Project Team. To do this, the workshop was provided with worksheets illustrating the different scenarios. The group was then asked to provide “pros” and “cons” for each scenario and mark up the drawings as they saw fit. The Project Team then incorporated the feedback into the refinement and finalization of the 6 development scenarios moving forward in the study.

For the full summary of the Working Group 3, see “Appendix A: Working Group Summaries”.

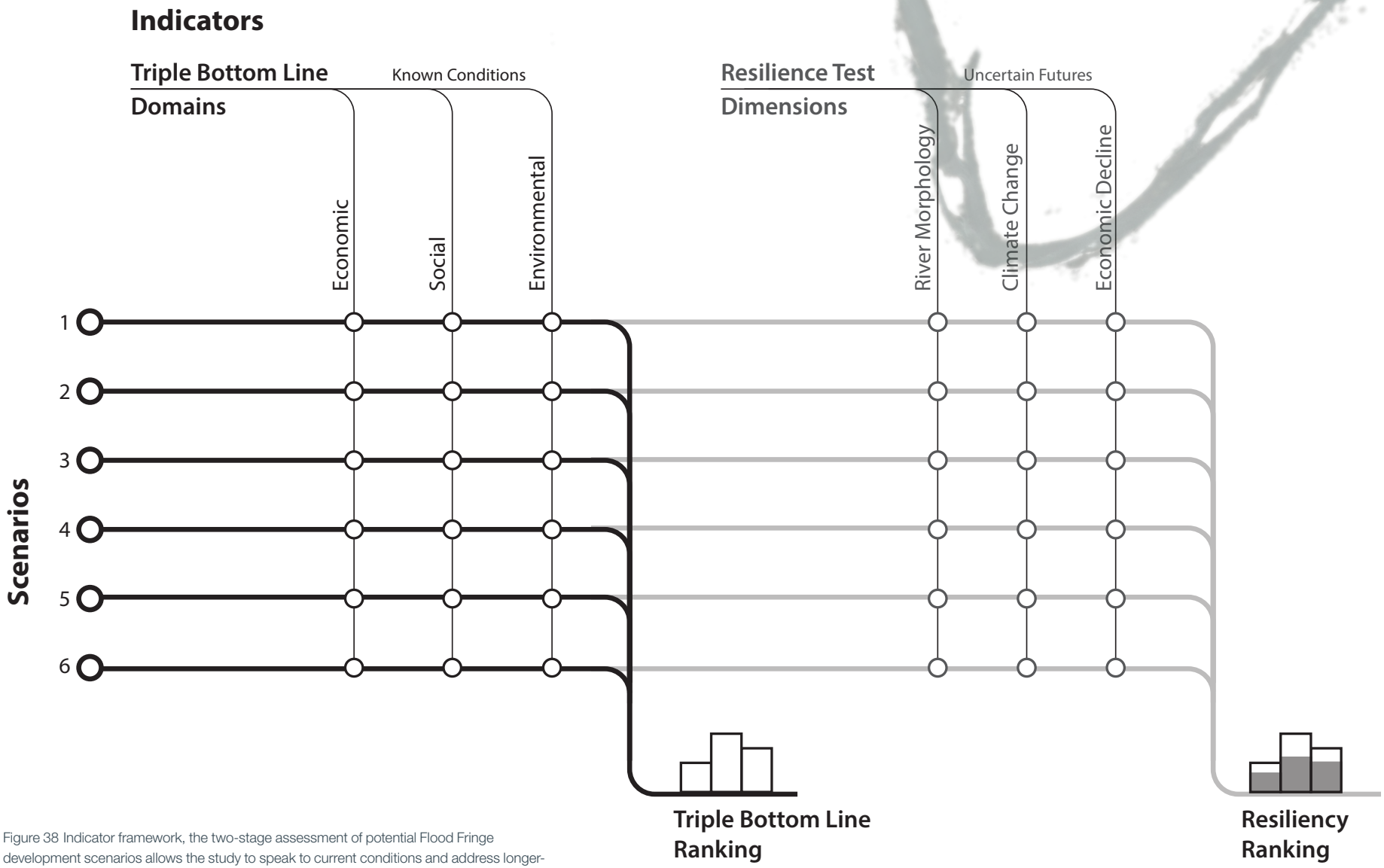


Figure 38 Indicator framework, the two-stage assessment of potential Flood Fringe development scenarios allows the study to speak to current conditions and address longer-term questions of resiliency.

5 Scoring

Informed by the Working Group values, City of Calgary priorities, technical studies and a review of current literature, a set of spatial and aspatial indicators were compiled to assess the impacts of each potential Flood Fringe Development Scenario. Indicators are useful when analyzing complex development scenarios because they provide a tool to assess individual components of the scenario while also drawing a broader picture of the cumulative development impacts. Using this compiled set of indicators, the Project Team developed a two-stage indicator framework, as illustrated in Figure 38, based on a Triple Bottom Line (TBL) approach.

In this framework, the Triple Bottom Line (TBL) first evaluates the development scenarios based on current conditions and knowledge. The second assessment, the Resilience Test, evaluates longer-term questions of resiliency, and analyzes the scenarios through a lens of "known uncertainties," including factors such as climate change, river morphology, and economic decline. This two-stage assessment allows the study to speak to both the known current conditions and shed light on the risks that each scenario may inherit in the future.

5.1 Test 1: Triple Bottom Line

A TBL approach considers economic, social, and environmental factors in decision-making processes. The City of Calgary's Triple Bottom Line Policy was adopted by Council in 2005 and acts as a framework to help staff consider and address social, economic, environmental and smart growth impacts in City business - including programs, planning, policies, strategies, services, operations and approvals.

The TBL approach is used in the Ricardo Ranch Flood Fringe Study to assess the economic, social and environmental impacts that could occur as a result of potential development scenarios in the Flood Fringe study area.

To assess the current viability of the potential Flood Fringe development scenarios, the first of the two-stage indicator framework conducts the TBL with the assumptions of current knowledge and understanding, without projecting into the future.

5.2 Test 2: Resilience Test

To assess their long-term viability, each scenario was tested against potential future economic and environmental conditions in a second assessment - the Resilience Test. The following outlines changes in the TBL base assumptions used in the Resilience Test:

1. **Climate change**: The changing climate may impact Calgary in various ways over the coming years. The city may see an increase in flooding frequency and intensity along the Bow River, and increasing risks to public safety and property adjacent to the river. Changes in climate may also have an effect on habitat quality and quantity in the city's riparian areas.
2. **River morphology**: The 200 year meander belt provides an indication of the potential for the Bow River to change course in the future, which could have a major impact on developed areas located adjacent to the river, floodway and flood fringe. A change in river morphology could potentially impact the viability of development, recreational use, bank stability, wildlife movement and riparian habitat in the flood fringe.
3. **Economic change**: An economic downturn may impact the viability of development in the Flood Fringe by reducing access to public and private funds for development while decreasing market demand for housing.

5.3 Indicator Development

To meet the requirements of The City of Calgary's Triple Bottom Line Policy and to reflect a broad range of public and stakeholder values associated with the Ricardo Ranch Flood Fringe Study Area, indicators were chosen to assess potential economic, social, and environmental impacts resulting from the potential Flood Fringe Development Scenarios. These indicators remain constant throughout both the TBL and Resilience Tests.

5.3.1 Indicator Rationale + Requirements

In order to effectively evaluate the impacts of the Scenarios, potential indicators were measured against the following criteria for their inclusion in this study:

- Indicators must be **measurable:** Data must be available to inform the scoring decisions for each Indicator.
- Indicators must be **defensible:** Indicators should be supported by the Working Group, City priorities, and current best practices.
- Indicators must be **distinct:** Indicators should be distinct from one another to avoid duplicating measurements.
- Indicators must be **differentiating:** Indicators should be chosen so that scenarios with measurable differences receive different scores.

The final indicators outlined in this report are different than those presented in the fourth Working Group workshop. Indicators were adjusted throughout the project based on Working Group feedback and the continued refinement of both the scenarios and the indicator assessment. Edits were made to create a more balanced analysis between environmental, social and economic indicators as well as to ensure both up-front land acquisition and land development costs were taken into account within the economic indicators.

5.3.2 Final Indicator Descriptions

The following indicators were used in the assessment for the Ricardo Ranch Flood Fringe Study. Each indicator was informed by Working Group feedback, City priorities and current best practices. The indicators are separated under Environmental, Social, and Economic headings to represent the potential development impacts in each of these TBL domains.

Environmental

Environmental indicators reflect the degree to which each scenario improves or compromises the existing natural habitats and functions provided by the study area today. Positive indicator values reflect restoration efforts and increases to natural cover, while negative values reflect loss of natural areas, or development and use of areas which provide important regional ecological services.

1. **Habitat and Water Management Along the Escarpment:** This indicator summarizes the likely degree of disturbance to the escarpment above the Flood Fringe from the development proposed in each scenario. Disturbance would result from the fill required to bring residential areas, recreational parkland, and stormwater treatment up to the required height above the flood hazard level.
2. **Riparian Habitat:** This indicator summarizes the degree of restoration or disturbance of riparian habitat in and around the study area proposed in each scenario. Restoration efforts may include naturalization and planting. Disturbance may arise from habitat loss (conversion of existing riparian areas to other land uses) or degradation (impacts to habitat quality due to human activities in and around the riparian area).
3. **Wildlife Connectivity:** This indicator summarizes the degree to which the scenario is likely to impact the movement of wildlife through the study area. The City of Calgary's classified Circuitscape connectivity raster was used to identify key wildlife movement areas.
4. **Wetland Quality and Quantity:** This indicator summarizes the degree to which the scenario impacts wetland area or function. Positive values are associated with the increase in total wetland area or improvements to the function of existing wetlands. Negative values represent loss of wetland area or a compromise in wetland function.

Social

Social indicators reflect the degree to which each scenario contributes to the social well-being of the city and of the area residents. Positive indicator values reflect the increased access to and appeal of the area for social activities such as recreation, nature appreciation, or scenic quality. Negative indicator values reflect decreased access to and appeal of the area for social activities.

5. **Aesthetic Appeal - Views into Site:** This indicator represents the visual appeal of the site when viewed from the highway and from the slopes above.
6. **Local Accessibility of Open Space:** This indicator represents the degree to which local residences have walkable access to the upper bench.
7. **Regional Accessibility of Open Space:** This indicator represents the degree to which the site will provide regional access to open space, including parks and recreation areas and connections to regional pathways. The presence of parking results in greater regional accessibility.
8. **Provision of Open Space Amenities:** This indicator represents the amount and accessibility of suitable public open space for area residents and the general public to engage in recreation, community events, cultural uses and other forms of celebration and gathering.
9. **Human Impacts due to Flooding:** This indicator assesses the potential consequences of flooding events and their impact on human safety and wellbeing. Positive indicator values reflect land uses that reduce the risk of flooding (through lands raised above the required flood level), or that minimize access and use of lands at risk of flooding. Negative indicator values reflect minimal to no precautions taken to reduce the risk of flooding or minimize access and use of lands at risk of flooding.

Economic

Economic indicators reflect the degree to which each scenario contributes to the economic value the area brings to the land owners and the degree to which the development of the area will impact City resources. Positive values indicate an increased economic contribution (through increased property values or reduced infrastructure and maintenance costs), whereas negative values indicated an increased public expense.

10. **Land Value and Property Enhancement - Inside Boundaries:** This indicator represents the degree to which the scenario enhances the monetary value of the study area land.
11. **Land Value and Property Enhancement - Adjacent Land:** This indicator represents the degree to which the scenario enhances the monetary value of the surrounding lands. Positive values indicate that the scenario provides important amenities or scenic views.
12. **Infrastructure Flood Damage Costs:** This indicator represents the likely costs incurred due to damage to infrastructure such as roads, parking lots, and stormwater features, should a 1:100+ year flood take place. Higher values indicate that infrastructure is either absent or located above the 1:100+ year flood level, while low values indicate the presence of at-risk infrastructure.
13. **Business and Tourism Development Impacts:** This indicator represents the degree to which commercial business and tourism development is supported by the scenario. This may include destination opportunities such as a brewery, performance space or conference centre, as well as rafting, guided tours and sport fishing operations. High indicator values reflect land uses that support these endeavours.
14. **Total Public Cost - Land Acquisition:** This indicator represents the total up-front public cost required by The City to acquire lands from the developer in each scenario. High values indicate a lower total acquisition area (and cost), while lower values indicate increasingly large areas of land required for purchase by The City.
15. **Total Public Cost - Development:** This indicator represents the total up-front public cost required in the scenario to develop or restore lands acquired from the developer by The City. High values indicate low up-front cost, while lower values indicate greater funding requirements.

Figure 40 View looking northwest from the western Flood Fringe study area toward Deerfoot Trail.

5.4 Scorecard

The scorecard is the tool that executes scenario evaluation. The Triple Bottom Line assessment is based on current conditions and current knowledge, and the Resilience Test is based on changing future uncertainties.

The statement of **desired performance** sets out the target state for the indicator. Each scenario will be scored based on the degree to which it supports or undermines this performance. The relative importance of these indicators will be applied in a separate weighting process.

The **weight** indicates the percentage contribution that each indicator offers to the final scenario score and was informed through a collaborative process with the Working Group (outlined in section 5.5). The final weighting was determined by taking the average weight per indicator from the WG4 workshop, rounding to the nearest whole number, and adjusting slightly based on the feedback and best practice for a cumulative weight total of 100.

Each scenario receives a score for each indicator according to the following rubric:

» 1.0 - Fully supports
» 0.5 - Partially supports
» 0.0 - Neutral
» -0.5 - Partially undermines
» -1.0 - Fully undermines

The cumulative scores for the scenarios determines the Triple Bottom Line score. The Resilience Test then re-scores each indicator based on revised resilience base assumptions, and provides a revised ranking and inherited set of risks for each scenario.

This two-stage assessment indicates a scenario that scores the highest according to the Triple Bottom Line assessment, and highlights the potential future risks associated with that scenario through the Resilience Tests (as seen in Figure 40).

TBL Domain	Indicator	Desired Performance	Weight	Score
Environmental	Habitat and Water Management Along Escarpment	The scenario has a positive impact on the ecological performances of the escarpment, including provision of habitat and water management.	7.00	
Environmental	Riparian Habitat	The scenario improves the quality or amount of riparian habitat.	7.00	
Environmental	Wildlife Connectivity	The scenario improves wildlife movement through the river valley corridor.	7.00	
Environmental	Wetland Quality and Quantity	The scenario improves the quality or amount of wetlands.	4.00	
Social	Aesthetic Appeal - Views into Site	The scenario provides high quality views into the site from publicly accessible locations around the study area (the escarpment and the highway).	6.00	
Social	Local Accessibility of Open Space	The scenario increases walkable access to open space in and around the Flood Fringe study area.	6.00	
Social	Regional Accessibility of Open Space	The scenario results in open space in or around the Flood Fringe study area that is supported by road access and some amount of public parking.	5.00	
Social	Provision of Open Space Amenities	The scenario provides open spaces that are appropriate for cultural uses, events, recreation, and celebration.	5.00	
Social	Human Impacts due to Flooding	The scenario minimizes the risk of damage and trauma resulting from floods.	10.00	
Economic	Land Value and Property Enhancement (Inside Boundaries)	The scenario captures and raises the monetary land value inside the study area.	7.00	
Economic	Land Value and Property Enhancement (Adjacent Land)	The scenario increases the monetary land value in surrounding areas.	7.00	
Economic	Infrastructure Flood Damage Costs	The scenario minimizes the risk of costs associated with infrastructure loss or damage from a flood.	10.00	
Economic	Business and Tourism Development Impacts	The scenario supports business and tourism development in the Flood Fringe and adjacent lands.	5.00	
Economic	Total Cost - Public Land Acquisition	The scenario minimizes up-front cost related to public land acquisition (land is privately held).	7.00	
Economic	Total Public Cost - Development	The scenario minimizes up-front public costs related to site preparation, reclamation, or amenity development.	7.00	
		Total	100.00	

Figure 41 Indicator Scorecard used for both the TBL and Resilience Tests.

Figure 42 Participants of working group 2 are assigning a weight to their ranked indicators during the “Indicator Brainstorm” Exercise.

5.5 Working Group Input

5.5.1 WG2 Indicator Workshop

Defining Success

As a step toward developing project indicators, the Working Group completed an exercise in small groups where they were tasked with defining success for the project from an environmental, social, and economic perspective. This exercise helped to lay the ground work for choosing appropriate indicators. Before we could ask ‘what to measure?’, we needed to ask ‘what to measure for?’.

Each group worked collaboratively to gather notions of what a successful outcome for the site might look like. All groups found moments of consensus, overlap, and divergence. Many groups agreed that flood safety, accessibility, and the establishment of a destination in the study area would create elements of success from a social perspective. Profitability and the provision of affordable housing options were shared notions of economic success between groups. Finally, effective stormwater management, protection of a healthy ecosystem, and a resilient environment were shared indications of environmental success.

Indicator Brainstorm

In the last workshop exercise of WG2, small groups were provided with a working set of potential Indicators. They were tasked with selecting, discarding, creating, and prioritizing these indicators.

First, groups ranked their indicators in order of perceived importance within each domain (environmental, social and economic). Once this arrangement was complete, each group was given 50 tokens and asked to ‘spend’ them across the indicators. Indicators that received a greater number of tokens were understood to have a higher importance to members of the group.

The indicator measuring the ‘Total Cost’ of development was assigned the highest weight among the potential indicators in every group. Working Group members noted that many other economic indicators could be encompassed by the ‘Total Cost’ indicator, signaling that it may not be a specific enough indicator for the TBL analysis.

For a full summary of WG2, see Appendix A.

5.5.2 WG4 Indicator Scorecard

The main purpose of the WG4 workshop was to gather thoughts and comments about the draft scorecard indicators and scenarios as the Working Group experimented with the scorecard prototype.

The workshop was divided into two main exercises:

» Weight Adjustment
» Exploration

Weight Adjustment

The main goal of Exercise 1 was to assess the indicators and their associated weighting, in isolation from the scenarios. To do so, the working group was divided into groups and each group was equipped with a laptop with access to the working scorecard file. The scorecard file was arranged to display the indicator, the associated TBL domain, the desired performance statement, and a weight. Based on best practice and professional knowledge, each group was asked to assign an appropriate weight to each indicator, with the cumulative weight of all the indicators adding up to 100. At the end of this exercise, a summary was displayed reflecting the ranking of each scenario based on these new weights.

Exploration

Exercise 2 asked the working group to push the scorecard further. They were asked to try to "beat the scorecard," attempting to make one scenario out-rank another to see if any indicators were redundant, too strong, not strong enough, or impacting the scenarios in strange or expected ways. The changing scenario ranking was displayed in real time, allowing the working group to play with the scorecard and explore which indicators affected what.

The scenarios were also subject to scrutiny during this exercise. The working group provided answers to questions such as; were the scenarios different enough from each other? Were the land uses clear? And could any scenarios be eliminated?

For a full summary of WG4, see Appendix A.

Figure 43 Participants of working group 4 are assessing the indicators and their associated weighting, strengthening the scorecard.

Figure 44 View of the existing farmhouse in the Ricardo Ranch study area.

6 Analysis

Six potential Flood Fringe development scenarios were created using the Ricardo Ranch land use palette. Each of these scenarios were assessed based on the indicator framework outlined in Section 5.

The following pages summarize the six scenarios and the results of the TBL assessment and Resiliency Test for each scenario.

6.1 Scenario 1: Baseline - Current Conditions

Scenario 1 (S1): Baseline scenario leaves the study area in its current condition. The scenario includes the construction of a paved Regional Pathway, north of the meander belt, as part of The City of Calgary's Open Space Strategy. Public use of the pathway will likely result in a minor increase in informal access into the floodway and former agricultural lands. Environmental impacts are anticipated to be relatively low in this scenario, and it may be assumed that the economic and social benefits would also be minor.

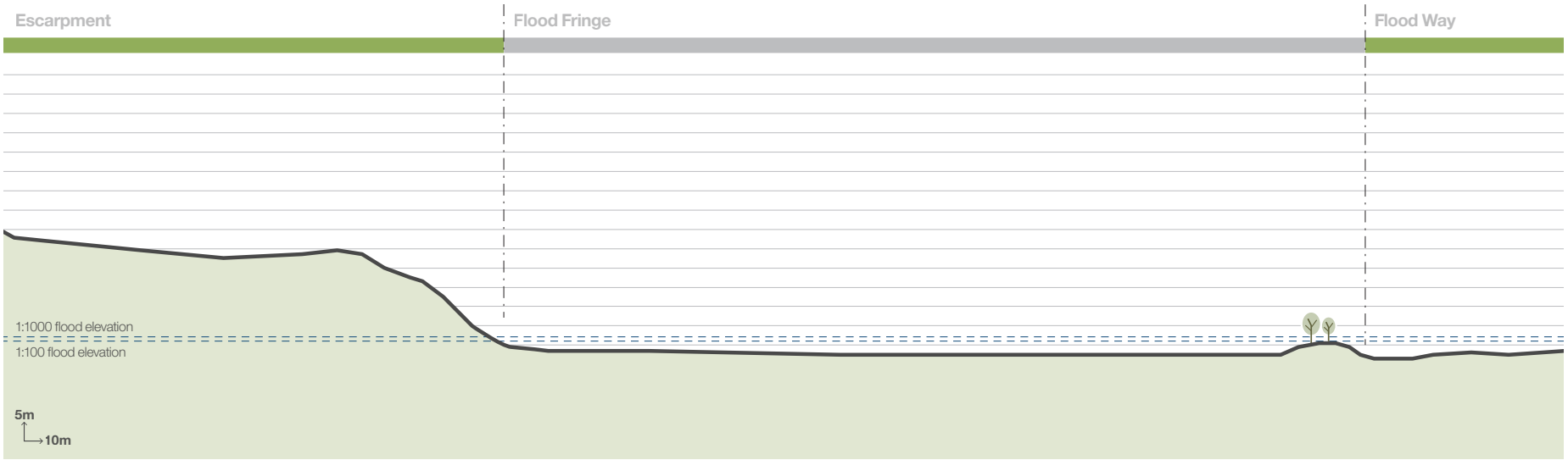
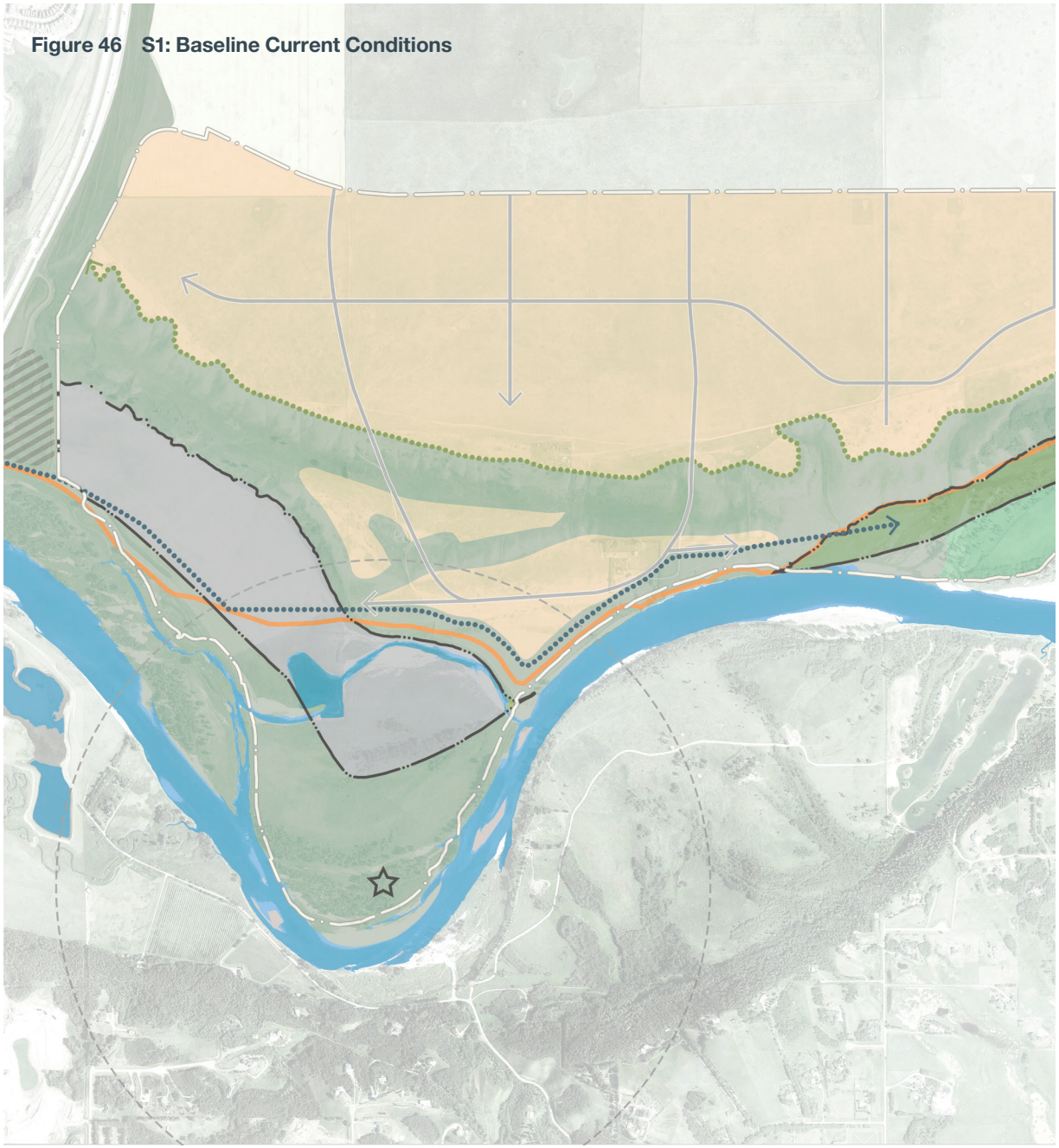
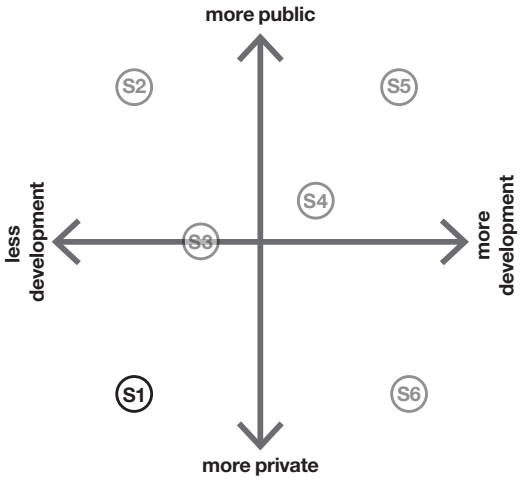


Figure 45 Illustrative section of S1: Baseline - Current Conditions.

Figure 46 S1: Baseline Current Conditions





Flood Fringe boundary
ASP boundary
ASP proposed access
200 year meander belt
ASP proposed escarpment green corridor
ASP proposed green corridor (regional pathway)
Provincial lands
Naturalized stormwater facilities
Post-industrial / agriculture
1000m buffer from Great Blue Heron colony
Great Blue Heron colony nesting site

0 125 250 500m

S1: Baseline - Current Conditions | Triple Bottom Line

TBL Domain	Indicator	Desired Performance	Weight	S1 Score	S1 Weighted	S1- Justification Statement
Environmental	Habitat and Water Management Along Escarpment	The scenario has a positive impact on the ecological performances of the escarpment, including provision of habitat and water management.	7.00	0	0	No impacts to the escarpment.
Environmental	Riparian Habitat	The scenario improves the quality or amount of riparian habitat.	7.00	0	0	No improvements to riparian habitat.
Environmental	Wildlife Connectivity	The scenario improves wildlife movement through the river valley corridor.	7.00	0	0	No change in existing connectivity.
Environmental	Wetland Quality and Quantity	The scenario improves the quality or amount of wetlands.	4.00	0	0	No impacts to existing wetlands, no newly constructed wetlands.
Social	Aesthetic Appeal - Views into Site	The scenario provides high quality views into the site from publicly accessible locations around the study area (the escarpment and the highway).	6.00	0	0	The views into the area remain unchanged, including vast open spaces and views to the river.
Social	Local Accessibility of Open Space	The scenario increases walkable access to open space in and around the Flood Fringe study area.	6.00	-1	-6	The scenario assumes the area is not publicly accessible, therefore the accessible open space within the study area is restricted to the Green Corridor Pathway (Regional Pathway).
Social	Regional Accessibility of Open Space	The scenario results in open space in or around the Flood Fringe study area that is supported by road access and some amount of public parking.	5.00	-1	-5	The scenario does not include facilities to support regional access (e.g. vehicle access and public facilities).
Social	Provision of Open Space Amenities	The scenario provides open spaces that are appropriate for cultural uses, events, recreation, and celebration.	5.00	-1	-5	The lack of vehicular access and public facilities limits these types of uses.
Social	Human Impacts due to Flooding	The scenario minimizes the risk of damage and trauma resulting from floods.	10.00	1	10	There is no development in the Flood Fringe.
Economic	Land Value and Property Enhancement (Inside Boundaries)	The scenario captures and raises the monetary land value inside the study area.	7.00	-1	-7	The scenario does not present any opportunities for an increase in monetary land value.
Economic	Land Value and Property Enhancement (Adjacent Land)	The scenario increases the monetary land value in surrounding areas.	7.00	-1	-7	The scenario does not present any opportunities for an increase in the land value of the adjacent benches and table lands.
Economic	Infrastructure Flood Damage Costs	The scenario minimizes the risk of costs associated with infrastructure loss or damage from a flood.	10.00	1	10	The Flood Fringe currently has minimal infrastructure.
Economic	Business and Tourism Development Impacts	The scenario supports business and tourism development in the Flood Fringe and adjacent lands.	5.00	-1	-5	There is potential for business and tourism development related to Ricardo Ranch, however it is currently private land.
Economic	Total Cost - Public Land Acquisition	The scenario minimizes up-front cost related to public land acquisition (land is privately held).	7.00	-1	-7	This scenario has a high upfront cost of land acquisition. No tax revenues are generated.
Economic	Total Public Cost - Development	The scenario minimizes up-front public costs related to site preparation, reclamation, or amenity development.	7.00	0	0	This scenario has no reclamation or development costs. No tax revenues are generated.
		Totals	100	-5	-22	

6.1.1 S1 Triple Bottom Line

The Baseline Scenario makes no changes or improvements to the existing condition of the land, therefore its impact on environmental indicators is non-existent, with each indicator given a zero score. Social and Economic indicators score poorly, as the area brings no improvement in local or regional access to open space, providing no improvements to the scenic quality or tourism viability of the area, and no likely return on investment for the lands. As no infrastructure is built in the area, potential for flood damage is negligible. Similarly, the lack of attractive draws for recreational use of the area, coupled with the lack of access and parking infrastructure, mean that human risk during flooding events is unlikely. Public expense of acquisition is high, while public redevelopment costs are non-existent.

This scenario receives a final weighted TBL score of -22, ranking last of the 6 scenarios evaluated.

Figure 47 View of the dug-out and first bench from the western study area.

S1: Baseline - Current Conditions | Resiliency Test

		1.	2.	3.	
TBL Domain	**Indicator**	**River Morph.**	**Climate Change**	**Econ. Decline**	**S1 Resilience Justification Statement**
Environmental	Habitat and Water Management Along Escarpment	-0.5	0	0	Changes to river morphology may result in increased erosion of the escarpment.
Environmental	Riparian Habitat	-0.5	0.5	0	Changes to river morphology may lead to the loss of existing riparian vegetation. Increased riparian recruitment during flood events may lead to increases in riparian area.
Environmental	Wildlife Connectivity	-0.5	0	0	Changes to river morphology may result in decreased options for wildlife movement through this area.
Environmental	Wetland Quality and Quantity	-0.5	-0.5	0	Changes to river morphology and increased flood likelihood and severity may result in loss of existing wetlands.
Social	Aesthetic Appeal - Views into Site	-0.5	0	0	Changes to river morphology may result in the loss of existing natural vegetation.
Social	Local Accessibility of Open Space	-1	-1	-1	
Social	Regional Accessibility of Open Space	-1	-1	-1	Flooding may impact regional pathway access.
Social	Provision of Open Space Amenities	-1	-1	-1	Flooding may impact regional pathway access.
Social	Human Impacts due to Flooding	1	1	1	While the regional pathway may be impacted by flooding events, the lack of amenities means that the area is not a destination for activity, and there are likely to be few people in the area during a flood.
Economic	Land Value and Property Enhancement (Inside Boundaries)	-1	-1	-1	
Economic	Land Value and Property Enhancement (Adjacent Land)	0.5	-1	-1	Shifts in the river may result in increased numbers of river adjacent lots on the bench lands, increasing their potential value.
Economic	Infrastructure Flood Damage Costs	0.5	0.5	1	Shifts in the river and increased flooding may cause damage to regional pathway infrastructure.
Economic	Business and Tourism Development Impacts	-1	-1	-1	
Economic	Total Cost - Public Land Acquisition	-1	-1	-1	
Economic	Total Public Cost - Development	0	0	0	
	Total:	-32	-25.5	-22	

No change observed from Triple Bottom Line.

6.1.2 S1 Resilience

6.1.2.1. River Morphology

Potential changes to river morphology is likely to reduce ecological function, impeding connectivity and leading to erosion of the embankment and loss of bank habitat.

Score: -32
Rank: 2 out of 6

6.1.2.2. Climate Change

Increased flooding events may lead to recruitment of cottonwood stands, increasing riparian cover in the remaining lands.

Score: -25.5
Rank: 5 out of 6

6.1.2.3. Economic Decline

Potential economic downturns would have little effect on this scenario, likely only impacting the maintenance of the regional pathway.

Score: -22.0
Rank: 6 out of 6

6.1.3 S1 Summary

The Baseline scenario, leaves the land in an undeveloped state. When analyzed through the lens of current conditions and knowledge, this scenario scores last on the TBL. The scenario does not provide any improvements to the Flood Fringe land or the lands surrounding it.

Through the resiliency lens, the Baseline scenario does not improve under stress, provide support to its surroundings, or contribute positively to the area as a whole. The scenario ranks second in the river morphology category, however, this category shows the largest negative change in score for the scenario, shifting from a total TBL score of -22, to a River Morphology total score of -32.

The two-stage indicator framework ranks the Baseline scenario in the bottom half of the 6 scenarios in both the TBL and Resilience tests.

		S1	Rank
	TBL Analysis	-22.0	6/6
Resilience Test	River Morphology	-32.0	2/6
	Climate Change	-25.5	5/6
	Economic Decline	-22.0	6/6

Figure 48 View into the existing riparian habitat located in the floodway adjacent to the western portion of the study area.

6.2 Scenario 2: Natural Park

Scenario 2 (S2): Natural Park will revitalize the study area as natural space and improve its ecological functionality through planting, native vegetation, and an improved, naturalized stormwater pond north of the 200-year meander belt. This scenario assumes that public access is limited to the trail network throughout the natural park and the Regional Pathway. The Regional Pathway will facilitate maintenance vehicles required to service the stormwater pond, but no additional road access will be constructed.

It may be assumed that this scenario will result in an overall environmental benefit, as the increased native riparian vegetation will improve the ecological health and resiliency of the Flood Fringe. The proximity to the table lands provides residents with direct access to the natural park, resulting in anticipated social benefits for those communities. However, economic benefits are anticipated to be minor.

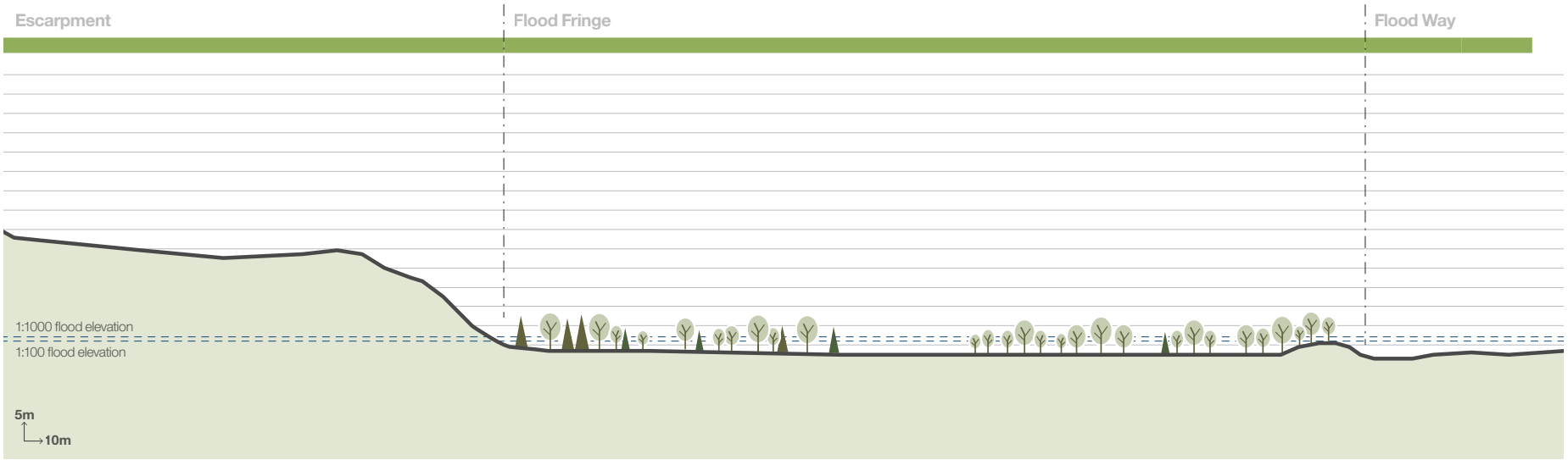
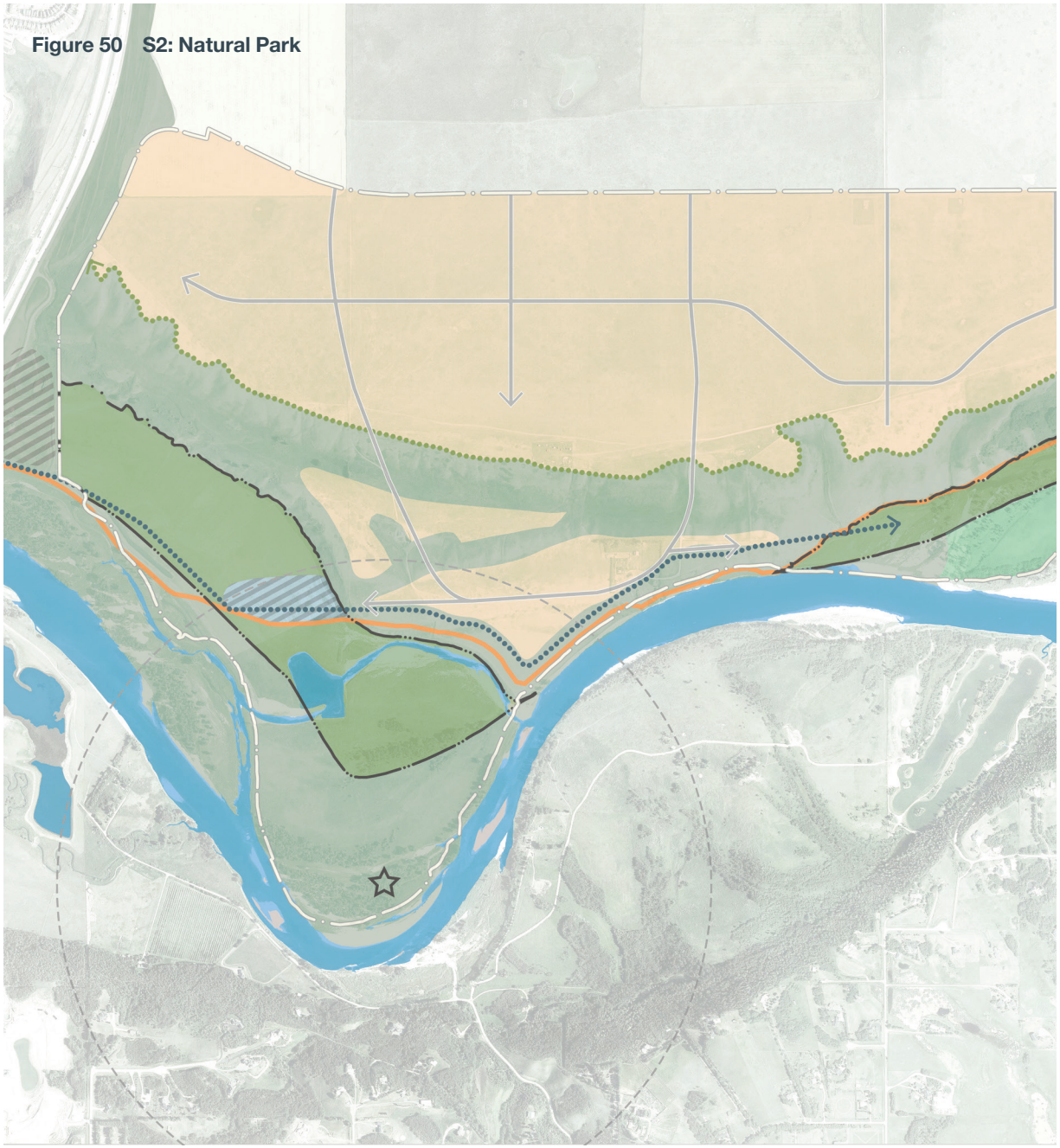
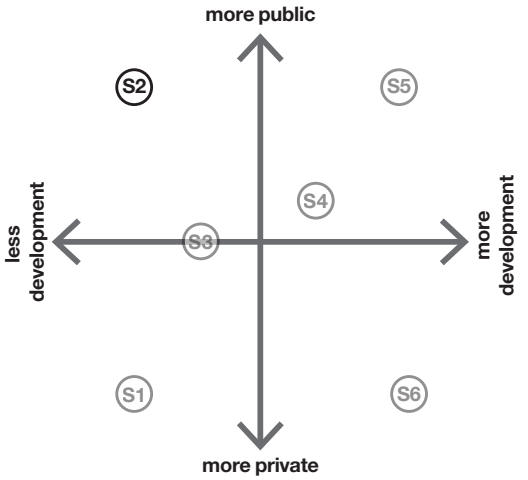


Figure 49 Illustrative section of S2: Natural Park.

Figure 50 S2: Natural Park





Flood Fringe boundary

ASP boundary

ASP proposed access

200 year meander belt

ASP proposed escarpment green corridor

ASP proposed green corridor (regional pathway)

Provincial lands

Natural park

Naturalized stormwater facilities

1000m buffer from Great Blue Heron colony

Great Blue Heron colony nesting site

0 125 250 500m

S2: Natural Park | Triple Bottom Line

TBL Domain	Indicator	Desired Performance	Weight	S2 Score	S2 Weighted	S2- Justification Statement
Environmental	Habitat and Water Management Along Escarpment	The scenario has a positive impact on the ecological performances of the escarpment, including provision of habitat and water management.	7.00	0	0	No impacts to the escarpment.
Environmental	Riparian Habitat	The scenario improves the quality or amount of riparian habitat.	7.00	1	7	Greatly increased area of riparian habitat
Environmental	Wildlife Connectivity	The scenario improves wildlife movement through the river valley corridor.	7.00	1	7	Improved wildlife connectivity within and throughout the area.
Environmental	Wetland Quality and Quantity	The scenario improves the quality or amount of wetlands.	4.00	1	4	Restoration of vegetation around existing wetlands, newly constructed naturalized stormwater wetland.
Social	Aesthetic Appeal - Views into Site	The scenario provides high quality views into the site from publicly accessible locations around the study area (the escarpment and the highway).	6.00	1	6	The natural areas and restoration create high-quality visual appeal into the site from publicly accessible locations.
Social	Local Accessibility of Open Space	The scenario increases walkable access to open space in and around the Flood Fringe study area.	6.00	-0.5	-3	Open space in the Flood Fringe and floodway is walkable from adjacent benches and table lands. Without a road, some residents may find access to be difficult.
Social	Regional Accessibility of Open Space	The scenario results in open space in or around the Flood Fringe study area that is supported by road access and some amount of public parking.	5.00	-1	-5	The scenario does not include facilities to support regional access (e.g. vehicle access and public facilities). Large natural areas may draw some regional visitors.
Social	Provision of Open Space Amenities	The scenario provides open spaces that are appropriate for cultural uses, events, recreation, and celebration.	5.00	-0.5	-2.5	Natural areas may include these types of spaces but the lack of vehicular access potentially limits this use.
Social	Human Impacts due to Flooding	The scenario minimizes the risk of damage and trauma resulting from floods.	10.00	-0.5	-5	There is no residential development in the Flood Fringe, however assuming a 1:100 year flood event, individuals potentially using the trail network at the time are at risk of being affected.
Economic	Land Value and Property Enhancement (Inside Boundaries)	The scenario captures and raises the monetary land value inside the study area.	7.00	-1	-7	Naturalization does not increase the monetary value of the land in the study area.
Economic	Land Value and Property Enhancement (Adjacent Land)	The scenario increases the monetary land value in surrounding areas.	7.00	0.5	3.5	Views into the river valley and walkable access to fairly private natural spaces increase the land value of adjacent benches and table lands.
Economic	Infrastructure Flood Damage Costs	The scenario minimizes the risk of costs associated with infrastructure loss or damage from a flood.	10.00	0.5	5	The stormwater pond may be at risk of flood damage, however the natural park has only minimal pathway and trail infrastructure.
Economic	Business and Tourism Development Impacts	The scenario supports business and tourism development in the Flood Fringe and adjacent lands.	5.00	-0.5	-2.5	Although limited access into the area precludes substantial commercial or tourism operations, there is some potential for business and tourism development on the table lands related to the natural park and river valley.
Economic	Total Cost - Public Land Acquisition	The scenario minimizes up-front cost related to public land acquisition (land is privately held).	7.00	-1	-7	This scenario has a high up-front public cost of land acquisition. No tax revenues are generated.
Economic	Total Public Cost - Development	The scenario minimizes up-front public costs related to site preparation, reclamation, or amenity development.	7.00	-0.5	-3.5	Natural park areas have high upfront public reclamation costs, and low up-front infrastructure costs.
		Total	100	-0.5	-3	

6.2.1 S2 Triple Bottom Line

The Natural Park Scenario scores highly in all environmental indicators baring the escarpment indicator, which is unchanged from the Baseline. Restoration and re-vegetation of disturbed lands will improve connectivity through the area, bolster riparian areas, and preserve wetlands. The lack of access and parking into the area precludes its use as a social space, as these lands are unlikely to be highly used by the public beyond those in neighbouring communities. Moderate improvements to land values in the surrounding areas are expected, due to scenic improvements and increased local parkland. Damage to infrastructure is likely to be minimized due to the extensive riparian vegetation buffer that this scenario provides. However, high public acquisition and development costs, and little opportunity for commercial or tourism development make this scenario score poorly for economic indicators.

The Natural Park scenario ranks 4th out of 6 in the TBL analysis, receiving a total weighted score of -3. The scenario fully supports most of the environmental indicators, while partially to fully undermining most of the economic and social indicators. This scenario does not result in a balanced TBL.

Figure 51: View into the existing riparian habitat located in the floodway adjacent to the western portion of the study area.

S2: Natural Park | Resiliency Test

		1.	2.	3.	
TBL Domain	Indicator	River Morph.	Climate Change	Econ. Decline	S2 Resilience Justification Statement
Environmental	Habitat and Water Management Along Escarpment	-0.5	0	0	Changes to river morphology may result in increased erosion of the escarpment.
Environmental	Riparian Habitat	0	1	1	Shifts in river morphology may lead to the loss of existing riparian areas. Flooding events may lead to increased cottonwood recruitment. Economic downturn may lead to reduced impacts to the existing riparian areas.
Environmental	Wildlife Connectivity	0.5	1	1	Large undisturbed areas allow for wildlife movement even after the river meanders.
Environmental	Wetland Quality and Quantity	0	0.5	1	Shifts in river morphology and increased flood volumes have potential impacts to constructed wetlands
Social	Aesthetic Appeal - Views into Site	0.5	1	0.5	Shifts in river morphology may lead to the loss of restored natural areas, economic declines may compromise the City's ability to support longer-term replanting efforts
Social	Local Accessibility of Open Space	-1	-0.5	-0.5	Shifts in river morphology may lead to escarpment instability, and impact access into the area from the benchlands.
Social	Regional Accessibility of Open Space	-1	-1	-1	Shifts in river morphology may impact regional pathway access
Social	Provision of Open Space Amenities	-1	-0.5	-0.5	Shifts in river morphology may lead to the loss of restored natural areas
Social	Human Impacts due to Flooding	-0.5	-0.5	-0.5	Increased flooding events may impact users of the regional trail network, limited emergency access may make response difficult.
Economic	Land Value and Property Enhancement (Inside Boundaries)	-1	-1	-1	
Economic	Land Value and Property Enhancement (Adjacent Land)	0.5	0.5	1	Shifts in the river may result in increased numbers of river adjacent lots on the bench lands, increasing their potential value.
Economic	Infrastructure Flood Damage Costs	-0.5	-0.5	0.5	Shifts in river morphology and increased flood risk may compromise stormwater and pathway infrastructure
Economic	Business and Tourism Development Impacts	-0.5	-0.5	-0.5	
Economic	Total Cost - Public Land Acquisition	-1	-1	-1	
Economic	Total Public Cost - Development	-0.5	-0.5	-0.5	
	Total:	-39.5	-15.0	-2.5	

No change observed from Triple Bottom Line.

6.2.2 S2 Resilience

6.2.2.1. River Morphology

Potential changes to river morphology will have impacts to the ecological function of the area, impacting riparian vegetation, wetlands and other restoration efforts. Likely routes of wildlife movement will be impacted and shifted closer to the embankment.

Score: -39.50
Rank: 4 out of 6

6.2.2.2. Climate Change

Increased flooding events due to climate change will help increase the establishment of new cottonwood trees, improving riparian habitat. Little overall impact to social indicators is expected, with potential impacts to the local accessibility and amount of the natural park area.

Score: -15.00
Rank: 1 out of 6

6.2.2.3. Economic Decline

Economic impacts will likely focus around potential damage to infrastructure, and the potential for increased land value to the adjacent lands following shifts bringing the river closer to the development.

Score: -2.50
Rank: 2 out of 6

6.2.3 S2 Summary

Under the TBL, the Natural Park scenario ranked 4th, with a score of -3.0. This scenario is strong in the environmental indicators, fully supporting most of them. With this in mind, it is logical it would rank first among the other scenarios when tested against the future impacts of climate change. With the establishment of a strong ecological-centric scenario today, an environmentally resilient scenario could exist in the future. In the face of economic decline, this scenario scores 2nd overall, with a 0.5 score increase from the TBL. Much of the financial risk of this scenario is understood even under current conditions.

		S2	Rank
	TBL Analysis	-0.5	4/6
Resilience Test	River Morphology	-39.5	4/6
	Climate Change	-15.0	1/6
	Economic Decline	-2.5	2/6

Figure 52. View of the existing farmhouse.

6.3 Scenario 3: Natural-Residential Hybrid

Scenario 3 (S3): Natural-Residential Hybrid creates a lower residential bench in the valley, capitalizing on the views to the river and to the adjacent natural park. This bench will be built above the 1:100 year flood event plus the additional 1m freeboard, reducing the risk to human safety from flood events of this category or lower.

The natural park gently slopes away from the residential area towards the river, creating a park with trail access to wrap the southern edge of the residential zone. The natural park provides a corridor that permits wildlife movement and facilitates the growth of improved riparian habitat. The residential area will also incorporate a setback from the toe of the slope to facilitate additional wildlife movement, convey drainage from the upper benches through the slopes, and improve the ecological function and stability of the slope.

This scenario assumes dual access roads into the residential area, and a public parking lot serving the natural park of approximately 0.2 hectares. The natural park will also support a trail network including access via the regional pathway. Public use of the park and trail network may result in minor increases in informal access into the floodway.

The natural park works to re-establish the health of the riparian vegetation in the Flood Fringe, and potentially improve the resiliency of the area to future flood events. With the high level of flood protection for the residential portion of this scenario and its proximity to natural amenities of the park and the Bow River, it is anticipated that this scenario receives higher net social and economic benefits, coupled with the increased environmental benefits of the natural park.

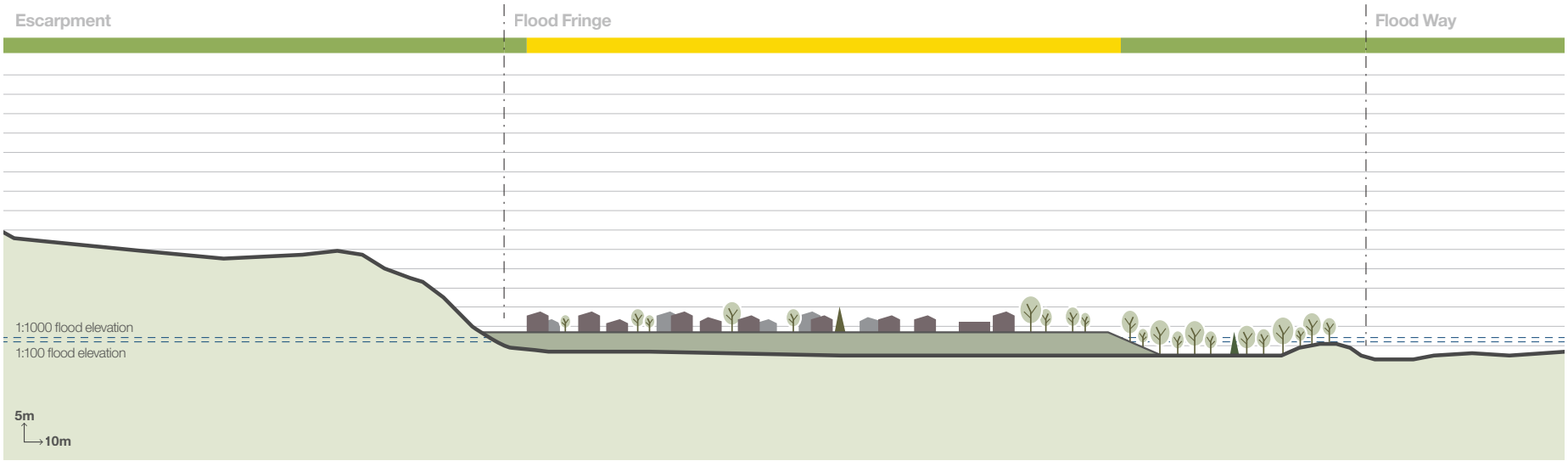
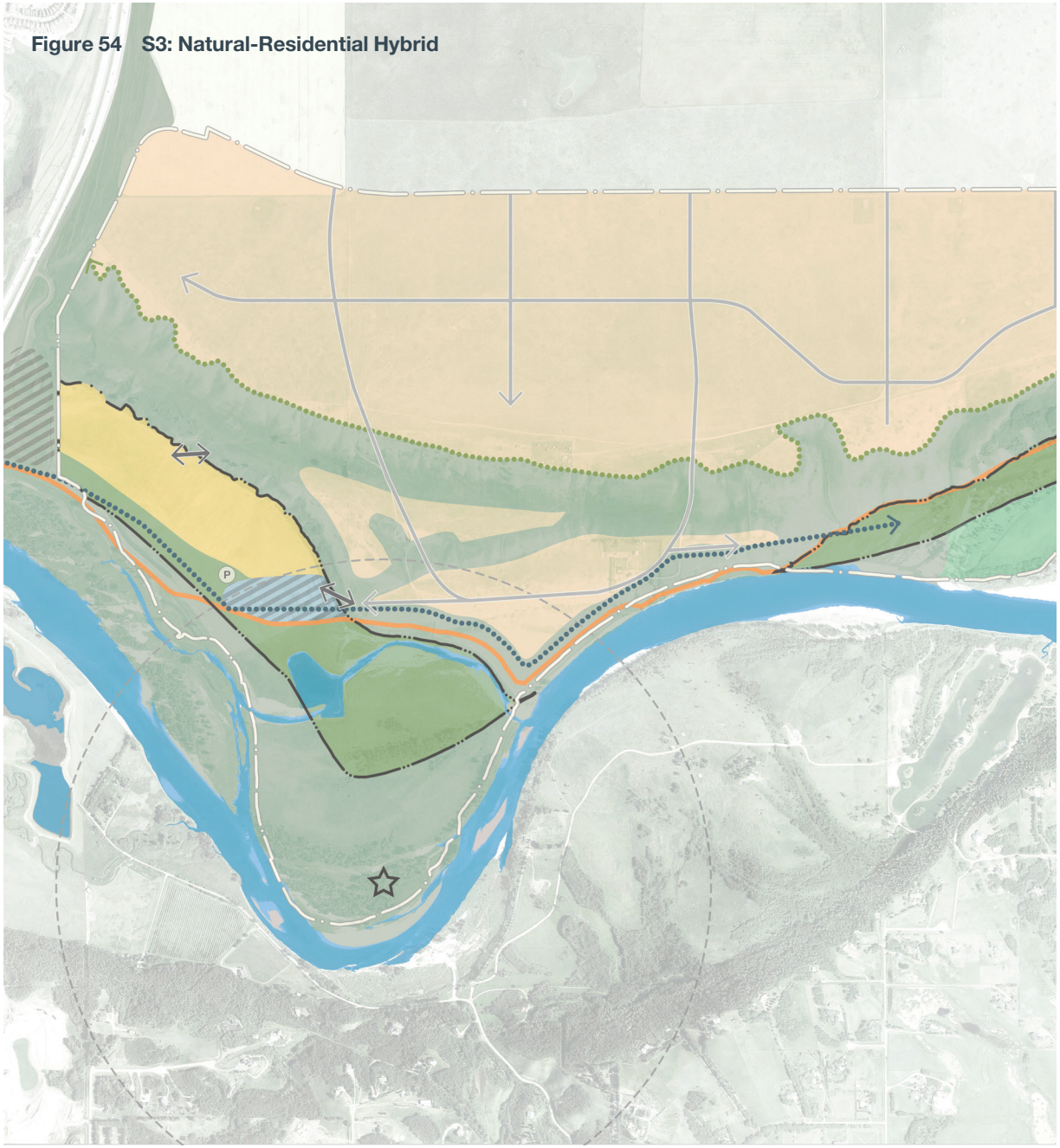
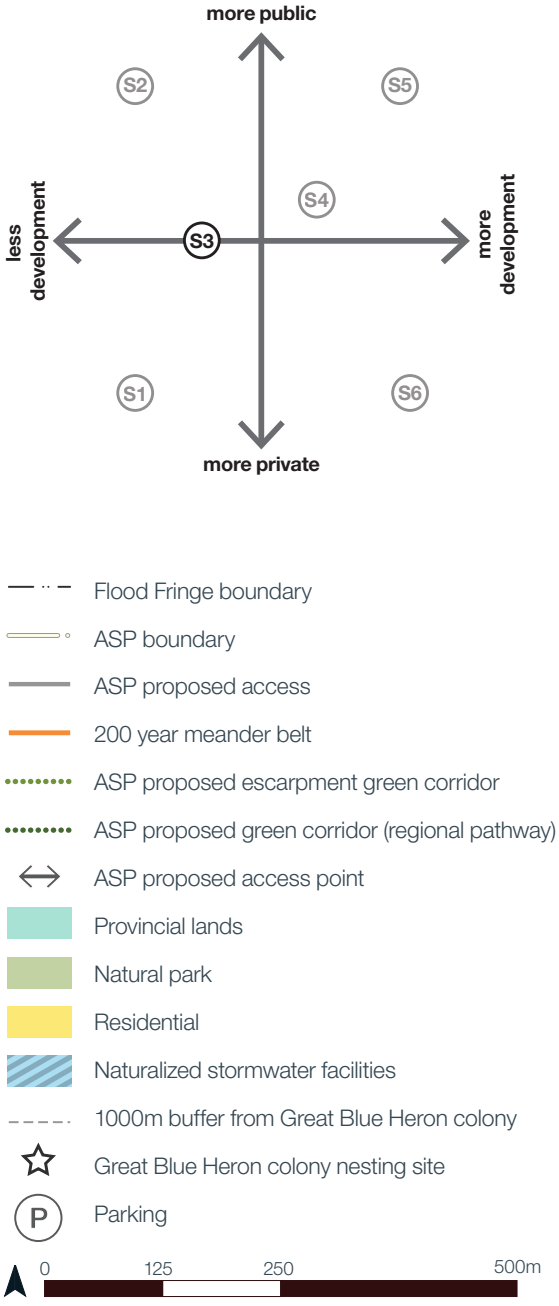


Figure 53 Illustrative section of S3: Natural-Residential Hybrid.

Figure 54 S3: Natural-Residential Hybrid





S3: Natural-Residential Hybrid | Triple Bottom Line

TBL Domain	Indicator	Desired Performance	Weight	S3 Score	S3 Weighted	S3- Justification Statement
Environmental	Habitat and Water Management Along Escarpment	The scenario has a positive impact on the ecological performances of the escarpment, including provision of habitat and water management.	7.00	-1	-7	5m of fill added along the escarpment.
Environmental	Riparian Habitat	The scenario improves the quality or amount of riparian habitat.	7.00	0.5	3.5	Moderately increased area of riparian habitat
Environmental	Wildlife Connectivity	The scenario improves wildlife movement through the river valley corridor.	7.00	0	0	Improved connectivity through the riparian area, coupled with reduced connectivity towards the escarpment.
Environmental	Wetland Quality and Quantity	The scenario improves the quality or amount of wetlands.	4.00	-0.5	-2	Loss of existing wetlands in Flood Fringe and escarpment, newly constructed naturalized stormwater wetland.
Social	Aesthetic Appeal - Views into Site	The scenario provides high quality views into the site from publicly accessible locations around the study area (the escarpment and the highway).	6.00	0.5	3	The public can access views to the Flood Fringe, floodway and river from the top of the escarpment and the natural park corridor in the Flood Fringe. Natural areas in the Flood Fringe increase the visual appeal.
Social	Local Accessibility of Open Space	The scenario increases walkable access to open space in and around the Flood Fringe study area.	6.00	1	6	Open space in the floodway and Flood Fringe is walkable for residents in the Flood Fringe and adjacent benches and table lands.
Social	Regional Accessibility of Open Space	The scenario results in open space in or around the Flood Fringe study area that is supported by road access and some amount of public parking.	5.00	0.5	2.5	Open space in the floodway is accessible via road access to a small parking lot within the Flood Fringe, natural park area.
Social	Provision of Open Space Amenities	The scenario provides open spaces that are appropriate for cultural uses, events, recreation, and celebration.	5.00	0.5	2.5	Residential and recreational land uses may include these types of spaces.
Social	Human Impacts due to Flooding	The scenario minimizes the risk of damage and trauma resulting from floods.	10.00	0.5	5	Assuming the residential area is built outside of the 1:100 year flood event, the risk of flood impacts is reduced. Constrained residential development and a naturalized buffer also reduce potential impacts.
Economic	Land Value and Property Enhancement (Inside Boundaries)	The scenario captures and raises the monetary land value inside the study area.	7.00	0.5	3.5	Low density residential housing and recreational areas by the river increase land value in the Flood Fringe.
Economic	Land Value and Property Enhancement (Adjacent Land)	The scenario increases the monetary land value in surrounding areas.	7.00	0.5	3.5	Vehicular access into the Flood Fringe, access to park space and the river, and views to natural areas in the Flood Fringe increase neighbouring land values.
Economic	Infrastructure Flood Damage Costs	The scenario minimizes the risk of costs associated with infrastructure loss or damage from a flood.	10.00	0.5	5	Assuming the residential area is built outside of the 1:100 year flood event, the risk of flood impacts is reduced. Natural park areas have minimal infrastructure.
Economic	Business and Tourism Development Impacts	The scenario supports business and tourism development in the Flood Fringe and adjacent lands.	5.00	0	0	There are limited opportunities for business and tourism in the Flood Fringe.
Economic	Total Cost - Public Land Acquisition	The scenario minimizes up-front cost related to public land acquisition (land is privately held).	7.00	-0.5	-3.5	This scenario has a moderate up-front public cost of land acquisition. No tax revenues are generated.
Economic	Total Public Cost - Development	The scenario minimizes up-front public costs related to site preparation, reclamation, or amenity development.	7.00	-0.5	-3.5	Natural park areas have moderate upfront public reclamation costs, and low up-front infrastructure costs.
		Total	100	2.5	18.5	

6.3.1 S3 Triple Bottom Line

The Natural-Residential Hybrid scenario will have impacts to the escarpment due to the fill required to lift the residential area above the flood-fringe. The restoration of the natural area will improve riparian quality and quantity, while moderately impacting wetlands along the escarpment and within the existing disturbed area. Social indicators score moderately high, providing easy access to open space and improving the visual quality of the landscape, while minimizing potential human costs of flooding events. Economic indicators are varied, as the scenario minimizes potential flood impacts to infrastructure, improves land values within and around the study area, and requires upfront public expense to purchase and restore the natural area.

This scenario ranked 1st out of the 6 evaluated scenarios, with a cumulative weighted score of 18.5. The Natural-Residential Hybrid scenario resulted in a well-balanced outcome between the three TBL domains, with indicators being fully or partially supported by the scenario.

Figure 55 View of the dug-out and Bow River from the lower benches, looking south.

S3: Natural-Residential Hybrid | Resiliency Test

		1.	2.	3.	
TBL Domain	Indicator	River Morph.	Climate Change	Econ. Decline	S3 Resilience Justification Statement
Environmental	Habitat and Water Management Along Escarpment	-1	-1	0	Changes to river morphology and increased flooding events may result in increased erosion of the escarpment. Economic downturn may reduce fill needed for developed areas.
Environmental	Riparian Habitat	-0.5	1	0.5	Shifts in river morphology may lead to the loss of existing riparian areas. Flooding events may lead to increased cottonwood recruitment.
Environmental	Wildlife Connectivity	-1	0	0	Residential areas may impede movement if natural lands are lost to the river.
Environmental	Wetland Quality and Quantity	-1	-1	-0.5	Increased flood volumes have potential impacts to constructed wetlands
Social	Aesthetic Appeal - Views into Site	-0.5	-0.5	-0.5	Changes to river morphology may result in loss of natural areas, and increased flooding events may lead to derelict houses in the residential area. Economic downturn may lead to derelict houses
Social	Local Accessibility of Open Space	0	1	1	Changes to river morphology may result in loss of natural areas
Social	Regional Accessibility of Open Space	0	0.5	0.5	Flooding may impact regional pathways and parking lot access
Social	Provision of Open Space Amenities	0	0.5	0.5	River shifts may impact the regional pathway
Social	Human Impacts due to Flooding	0.5	-1	0.5	People living in the residential development area may be impacted by extreme flooding events.
Economic	Land Value and Property Enhancement (Inside Boundaries)	0.5	0.5	-1	Low density suburban housing market may be compromised by economic downturn.
Economic	Land Value and Property Enhancement (Adjacent Land)	0.5	0.5	-0.5	Economic downturn may make large isolated lots less saleable, reducing value of nearby property.
Economic	Infrastructure Flood Damage Costs	-0.5	-1	0.5	Shifts in river morphology and increased flood risk may compromise stormwater, road networks, pathway infrastructure, and residential areas.
Economic	Business and Tourism Development Impacts	0	0	0	
Economic	Total Cost - Public Land Acquisition	-0.5	-0.5	-0.5	
Economic	Total Public Cost - Development	-0.5	-0.5	-0.5	
	Total:	-24.5	-16.0	-2.0	

No change observed from Triple Bottom Line.

6.3.2 S3 Resilience

6.3.2.1. River Morphology

Potential changes to river morphology may see the loss of natural areas, and potentially, residential lands as well. Riparian habitat will likely be lost as the river meanders.

Score: -24.50
Rank: 1 out of 6

6.3.2.2. Climate Change

Increased flooding due to climate change may see increased cottonwood establishment, dependent on the degree of maintenance and upkeep to development in the area. Increased flooding events may lead to human impacts, due both to the presence of regional parking (leading to increased use of riparian areas) and the residential community itself.

Score: -16.00
Rank: 2 out of 6

6.3.2.3. Economic Decline

The potential economic downturn may impact the saleability of the residential lots in the study area, which in turn may impact property values of the adjacent lands should the residential area remain unsold. Infrastructure costs will likely increase under both climate-driven flood increases, and from changes to the river morphology.

Score: 2.00
Rank: 1 out of 6

6.3.3 S3 Summary

This scenario ranked the highest in the TBL analysis and presented the most balanced scores between the indicators, with the majority of the indicators being either partially or fully supported. This balance seemingly increased the resiliency of this scenario, as it remained within the top two scenarios for each of the resilience assessments. The domain that faired the best through all three resilience tests was the social domain.

		S3	Rank
	TBL Analysis	18.5	1/6
Resilience Test	River Morphology	-24.5	1/6
	Climate Change	-16.0	1/6
	Economic Decline	2.0	1/6

Figure 56: Springs flowing from the escarpment of the lower benches.

6.4 Scenario 4: Recreation- Residential Hybrid

Scenario 4 (S4)" Recreation-Residential Hybrid establishes a new lower residential bench which overlooks the recreation park area. This bench will be built above the 1:100 year flood event, reducing the risk to human safety from flood events of this category or lower.

The recreation park provides both residents of the Flood Fringe, the upper benches, and table lands with good access to natural areas and the Bow River. The proximity and size of the recreation park makes this zone easily accessible both locally and regionally.

This scenario assumes that the recreation park will attract both local residents and a larger regional catchment. The scenario supports this by providing road access and a public parking lot of approximately 0.5 hectares. The scenario is accessible via the planned regional pathway and a trail network throughout the park. An amenity node increases additional uses, providing an opportunity for small-scale commercial opportunities such as restaurants, cafés, and/or equipment rental. All development and infrastructure are kept north of the 200 year meander belt to decrease the risk to human safety and damage to infrastructure due to future river morphological changes.

Increased public use may result in increased informal public access to the floodway, and potentially increased noise, light and other nuisances for both wildlife and human residents in the Flood Fringe. The amenities provided within the recreation park and the amenity node may provide increased social benefits to the residents of the benches and table lands.

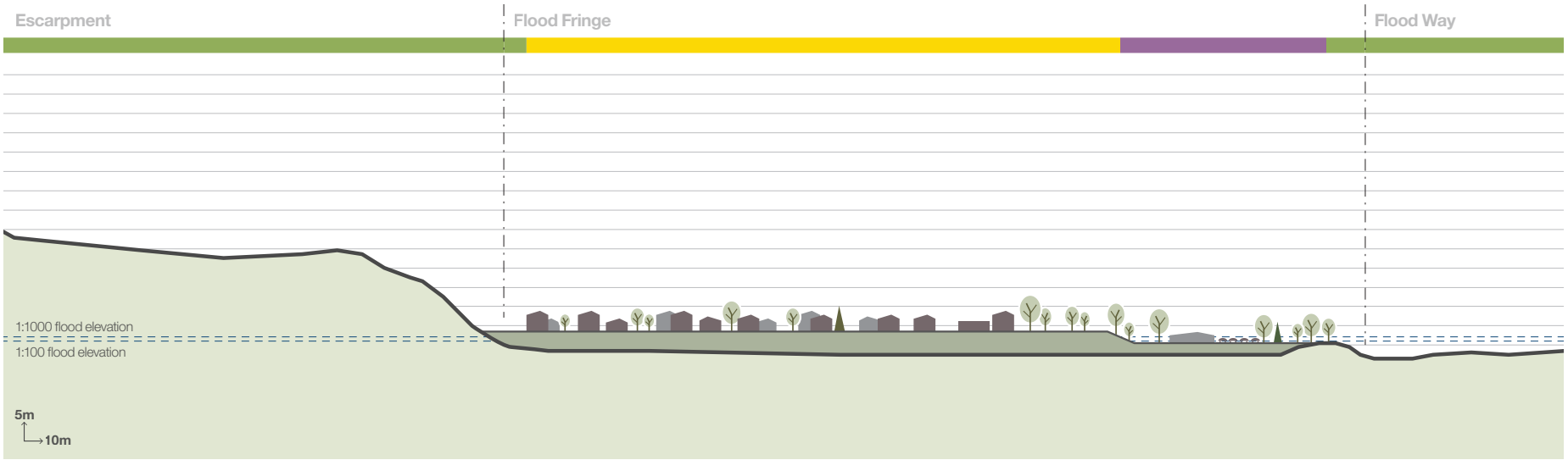
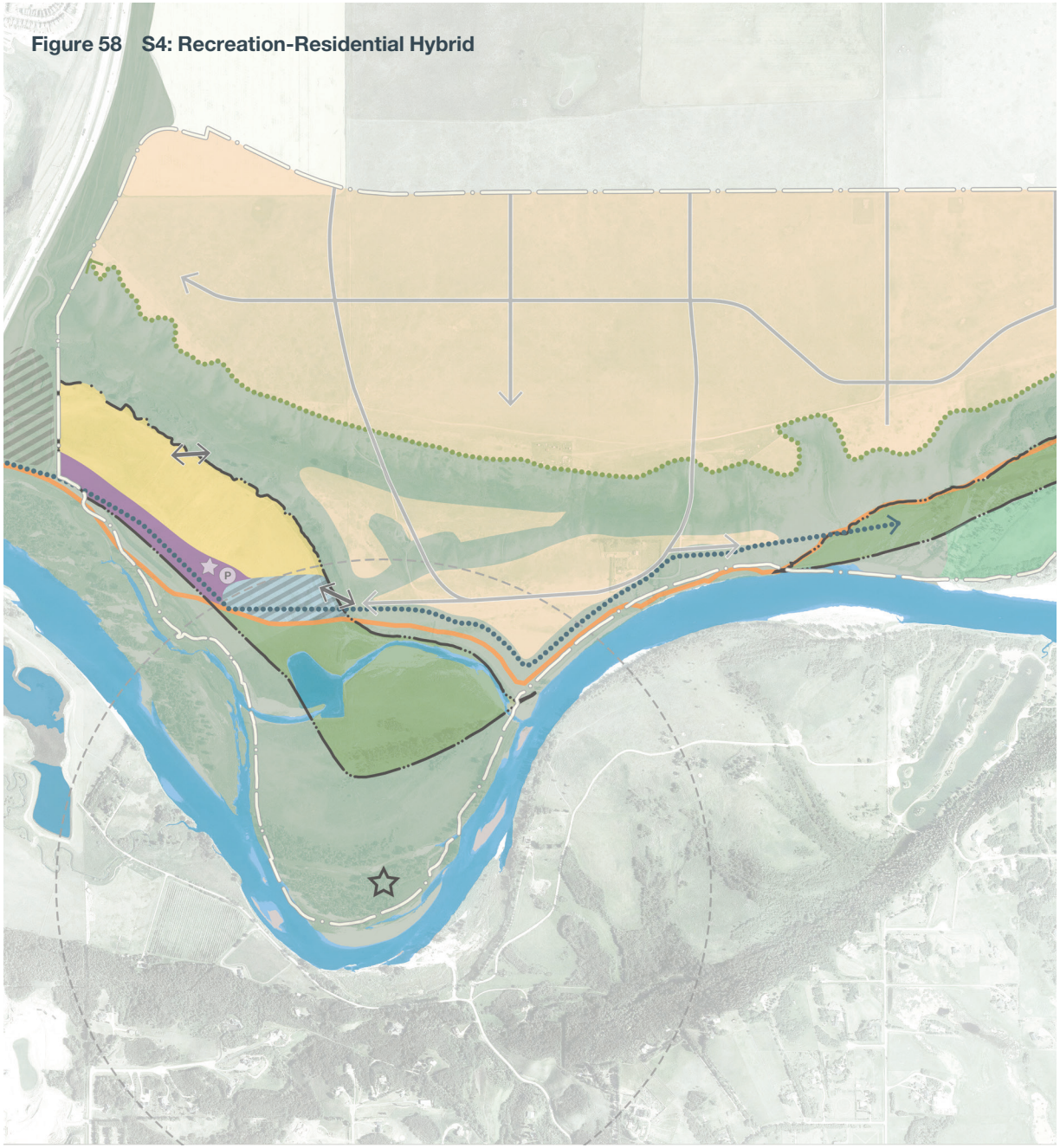


Figure 57 Illustrative section of S4: Recreation-Residential Hybrid.

Figure 58 S4: Recreation-Residential Hybrid



S4: Recreation-Residential Hybrid | Triple Bottom Line

TBL Domain	Indicator	Desired Performance	Weight	S4 Score	S4 Weighted	S4- Justification Statement
Environmental	Habitat and Water Management Along Escarpment	The scenario has a positive impact on the ecological performances of the escarpment, including provision of habitat and water management.	7.00	-1	-7	5m of fill added along the escarpment.
Environmental	Riparian Habitat	The scenario improves the quality or amount of riparian habitat.	7.00	-1	-7	No increase in riparian habitat, increased activities within existing habitat.
Environmental	Wildlife Connectivity	The scenario improves wildlife movement through the river valley corridor.	7.00	-1	-7	Reduced connectivity through the riparian area, coupled with reduced connectivity towards the escarpment.
Environmental	Wetland Quality and Quantity	The scenario improves the quality or amount of wetlands.	4.00	-0.5	-2	Loss of existing wetlands in Flood Fringe and escarpment, newly constructed naturalized stormwater wetland.
Social	Aesthetic Appeal - Views into Site	The scenario provides high quality views into the site from publicly accessible locations around the study area (the escarpment and the highway).	6.00	0.5	3	The public can access views to the Flood Fringe, floodway and river from the top of the escarpment and the recreational corridor in the Flood Fringe. The residential and recreation park areas may reduce the amount of natural vegetation within the viewshed.
Social	Local Accessibility of Open Space	The scenario increases walkable access to open space in and around the Flood Fringe study area.	6.00	1	6	Open space in the floodway and Flood Fringe is walkable for residents in the Flood Fringe and adjacent benches and table lands.
Social	Regional Accessibility of Open Space	The scenario results in open space in or around the Flood Fringe study area that is supported by road access and some amount of public parking.	5.00	0.5	2.5	Open space in the floodway and Flood Fringe is accessible via road and parking lot access to the Flood Fringe and from the regional pathway.
Social	Provision of Open Space Amenities	The scenario provides open spaces that are appropriate for cultural uses, events, recreation, and celebration.	5.00	0.5	2.5	Residential and recreation park land uses may include these types of spaces. The amenity node also provides additional potential opportunities.
Social	Human Impacts due to Flooding	The scenario minimizes the risk of damage and trauma resulting from floods.	10.00	0	0	Assuming the residential area is built outside of the 1:100 year flood event, the risk of flood impacts in this area is reduced. Potentially higher volumes of people in the recreation park area with fill protecting only to a 1:20 year flood event however increase potential risk of flood impacts.
Economic	Land Value and Property Enhancement (Inside Boundaries)	The scenario captures and raises the monetary land value inside the study area.	7.00	0.5	3.5	Low density residential housing increases the land value in the Flood Fringe. Larger recreation park areas may be a detraction for some buyers (more nuisance elements expected from recreational use).
Economic	Land Value and Property Enhancement (Adjacent Land)	The scenario increases the monetary land value in surrounding areas.	7.00	0.5	3.5	Vehicular access into the Flood Fringe, access to park space and the river, and views to natural areas in the Flood Fringe increase neighbouring land values.
Economic	Infrastructure Flood Damage Costs	The scenario minimizes the risk of costs associated with infrastructure loss or damage from a flood.	10.00	0	0	Assuming the residential area is built outside of the 1:100 year flood event, the risk of flood impacts is reduced. This scenario may have more risk of recreational infrastructure damage from flooding.
Economic	Business and Tourism Development Impacts	The scenario supports business and tourism development in the Flood Fringe and adjacent lands.	5.00	0.5	2.5	Larger recreational areas and with the amenity node increase opportunities for business and tourism in the Flood Fringe and adjacent benches and table lands.
Economic	Total Cost - Public Land Acquisition	The scenario minimizes up-front cost related to public land acquisition (land is privately held).	7.00	-0.5	-3.5	This scenario has a moderate up-front public cost of land acquisition. Some tax revenues may be generated by commercial recreation operations.
Economic	Total Public Cost - Development	The scenario minimizes up-front public costs related to site preparation, reclamation, or amenity development.	7.00	-0.5	-3.5	Recreation areas have moderate up-front infrastructure costs.
		Totals	100	-0.5	-6.5	

6.4.1 S4 Triple Bottom Line

The Recreation-Residential Hybrid Scenario will have impacts to the escarpment due to the fill required to lift the residential area above the flood-hazard level. The development of the recreation area will negatively impact riparian quality and quantity, leading to the loss of wetlands along the escarpment and within the existing disturbed area. Social indicators score moderately high, providing easy access to high quality open space, improving the visual quality of the landscape, while minimizing potential human costs of flooding events. Economic indicators are varied, as the scenario has potential flood impacts to newly developed infrastructure, improves land values within and around the study area, and requires upfront public expense to purchase and develop the recreation area.

This scenario is less balanced between the three TBL domains, resulting in a cumulative score of and ranking 5th out of the 6 evaluated scenarios.

Figure 59 Informal trails have formed in the Ricardo Ranch Flood Fringe study area.

S4: Recreation-Residential Hybrid | Resiliency Test

		1.	2.	3.	
TBL Domain	Indicator	River Morph.	Climate Change	Econ. Decline	S4 Resilience Justification Statement
Environmental	Habitat and Water Management Along Escarpment	-1	-1	0	Changes to river morphology and increased flooding events may result in increased erosion of the escarpment. Economic downturn may reduce fill needed for developed areas.
Environmental	Riparian Habitat	-1	0	0	Shifts in river morphology may lead to the loss of existing riparian habitat. Increased flooding events may lead to cottonwood recruitment. Economic downturn may preclude maintenance efforts by The City, reducing the area used for formal recreation.
Environmental	Wildlife Connectivity	-1	-1	-0.5	Residential areas may impede movement if natural lands are lost to the river. Economic downturn may reduce number of occupied residential units and thus promote increased movement through the residential areas.
Environmental	Wetland Quality and Quantity	-1	-1	-0.5	Increased flood volumes have potential impacts to constructed wetlands
Social	Aesthetic Appeal - Views into Site	0.5	-0.5	-0.5	Increased flooding events may lead to derelict houses in the residential area. Economic downturn may lead to derelict houses
Social	Local Accessibility of Open Space	0	1	1	Changes to river morphology may result in loss of natural areas and pathway systems.
Social	Regional Accessibility of Open Space	0	0	0.5	Changes to river morphology may lead to the loss of open space. Increased flooding events may impact regional pathways and parking lot access.
Social	Provision of Open Space Amenities	0	0.5	0	River shifts may lead to the loss of recreational areas. Economic downturn may preclude maintenance efforts
Social	Human Impacts due to Flooding	0	-1	0	People living in the residential development area, or using the recreation areas, may be impacted by extreme flooding events.
Economic	Land Value and Property Enhancement (Inside Boundaries)	0.5	0.5	-0.5	Low density suburban housing market may be compromised by economic downturn.
Economic	Land Value and Property Enhancement (Adjacent Land)	0.5	0.5	-0.5	Economic downturn may make large isolated lots less saleable, reducing value of nearby property.
Economic	Infrastructure Flood Damage Costs	-1	-1	0	Built infrastructure may be damaged or lost due to shifts in river morphology. Extreme flooding events may damage stormwater, recreational areas, or residential areas
Economic	Business and Tourism Development Impacts	-0.5	-0.5	-0.5	Impacts to recreation areas by shifts in river morphology and extreme flooding events may impact commercial activities. Economic downturn may compromise business models.
Economic	Total Cost - Public Land Acquisition	-0.5	-0.5	-0.5	
Economic	Total Public Cost - Development	-0.5	-0.5	-0.5	
	Total:	--34.5	-35.0	-16.5	

No change observed from Triple Bottom Line.

6.4.2 S4 Resilience

6.4.2.1. River Morphology

Potential changes to river morphology may see the loss of the recreation area, and potentially the residential lands. Riparian habitat will be lost as the river meanders, although increased flooding may see increased cottonwood establishment, dependent on the degree of maintenance and upkeep to development in the area.

Score: -34.50
Rank: 3 out of 6

6.4.2.2. Climate Change

Increased flooding events due to climate change will likely lead to human impacts, due both to the presence of regional parking (leading to extensive use of both the recreation and riparian areas) and the residential community itself.

Score: -35.00
Rank: 6 out of 6

6.4.2.3. Economic Decline

The potential economic downturn may impact the saleability of the residential lots in the study area, which in turn may impact property values of the adjacent lands should the residential area remain unsold. Furthermore, poor economic conditions may compromise the intended business plan of commercial development in the area. Infrastructure costs will likely increase under both climate-driven flood increases, and from changes to the river morphology. There is potential required future public investment in bank stabilization or retaining walls to protect the residential area.

Score: -16.50
Rank: 4 out of 6

6.4.3 S4 Summary

The Recreation-Residential Hybrid Scenario initially ranks low in the TBL assessment (5th), and remains in the bottom half of the scenarios for both the Climate Change and Economic Decline resilience tests. This two-stage analysis highlights that this scenario may not make much sense given current conditions and under stress.

		S4	Rank
	TBL Analysis	-6.5	5/6
Resilience Test	River Morphology	-34.5	3/6
	Climate Change	-35.0	6/6
	Economic Decline	-16.5	4/6

Figure 60 Looking northeast towards the dug-out and the lower bench from the berm.

6.5 Scenario 5: Recreation + Nature Park

Scenario 5 (S5): Recreation + Nature Park establishes a recreational destination, with no residential uses. Higher intensity uses are located closer to the escarpment, becoming increasingly naturalized towards the river. The scenario establishes a higher intensity public use for the dug-out and river channel, potentially for water activities such as swimming or non-motorized boating. This scenario also provides an amenity node, concentrating an opportunity for additional small-scale commercial uses, such as restaurants, cafés, and/or sports equipment rental.

This scenario assumes a public access road and a public parking lot of approximately 1 ha in size that supports the recreation and nature park, and the amenity node. The recreation park will be built upon 3-5 metres of fill, to provide adequate flood event protection for a non-residential area. The natural park will slope towards the river. The total amount of fill used in this scenario is reduced in comparison to other scenarios that contain residential zones.

The natural park also establishes a wildlife corridor and enhances the riparian vegetation in the Flood Fringe, increasing the environmental benefits of this scenario. Due to the public nature of this scenario it is anticipated that this scenario may have minimal economic benefits. However, the net social and environmental benefits may be increased.

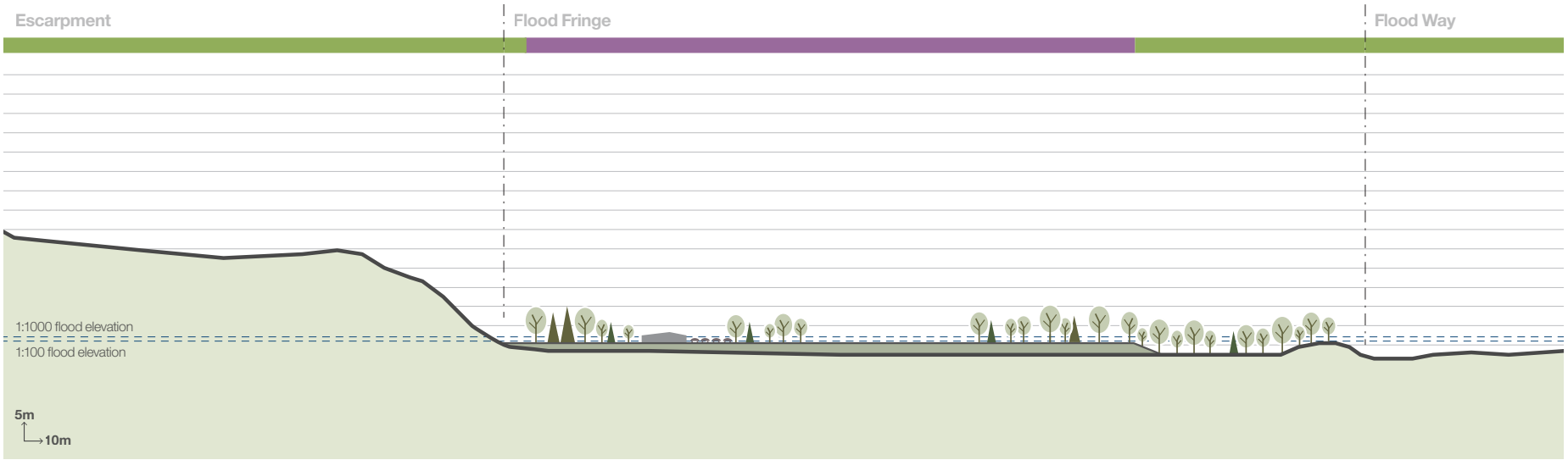
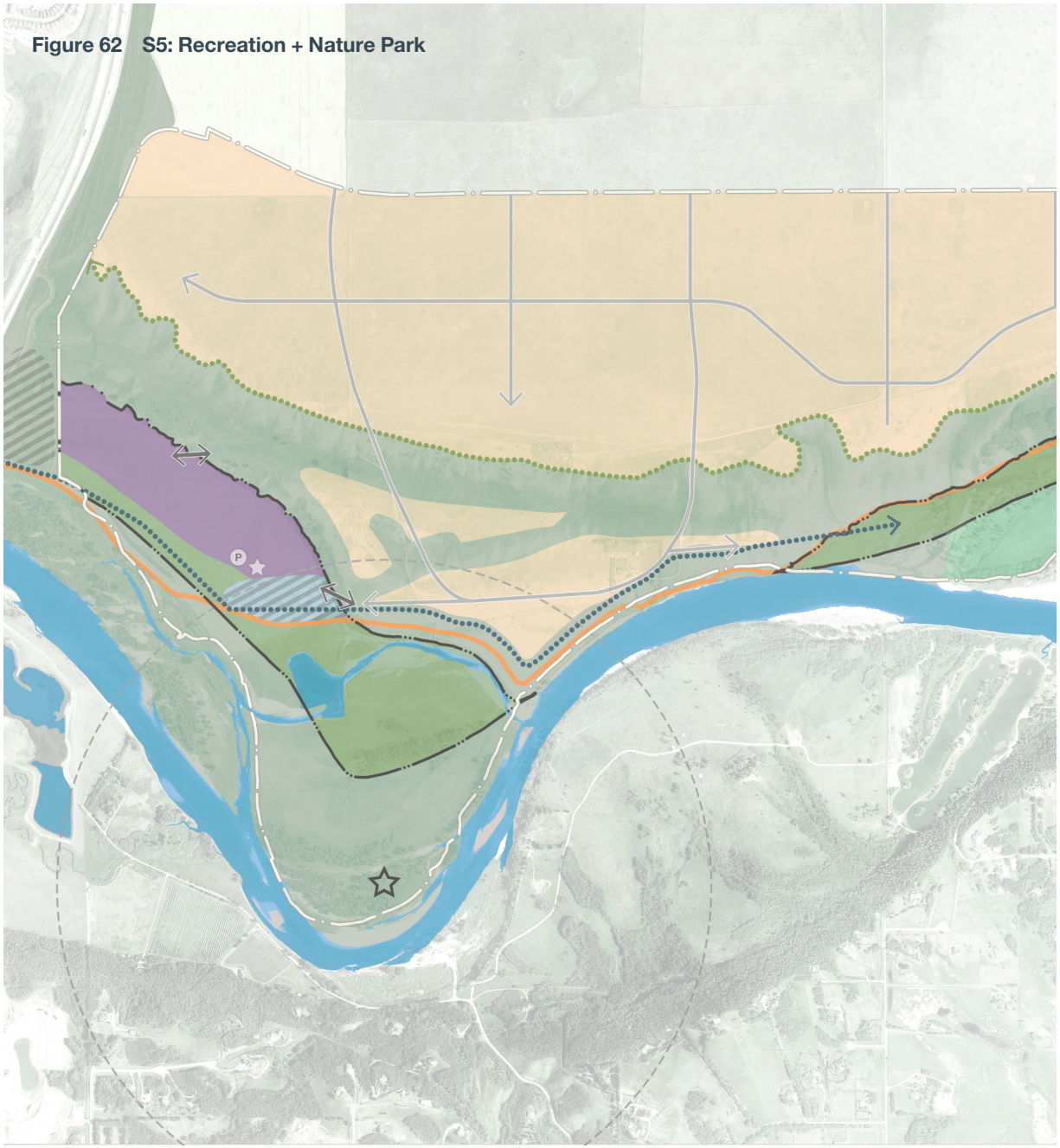


Figure 61 Illustrative section of S5: Recreation + Nature Park.

Figure 62 S5: Recreation + Nature Park



S5: Recreation + Nature Park | Triple Bottom Line

TBL Domain	Indicator	Desired Performance	Weight	S5 Score	S5 Weighted	S5- Justification Statement
Environmental	Habitat and Water Management Along Escarpment	The scenario has a positive impact on the ecological performances of the escarpment, including provision of habitat and water management.	7.00	-0.5	-3.5	3m of fill added along the escarpment.
Environmental	Riparian Habitat	The scenario improves the quality or amount of riparian habitat.	7.00	0.5	3.5	Moderately increased area of riparian habitat.
Environmental	Wildlife Connectivity	The scenario improves wildlife movement through the river valley corridor.	7.00	0	0	Improved connectivity through the riparian area, coupled with reduced connectivity towards the escarpment.
Environmental	Wetland Quality and Quantity	The scenario improves the quality or amount of wetlands.	4.00	0	0	Loss of existing wetlands in Flood Fringe, newly constructed naturalized stormwater wetland.
Social	Aesthetic Appeal - Views into Site	The scenario provides high quality views into the site from publicly accessible locations around the study area (the escarpment and the highway).	6.00	1	6	The public can access views to the Flood Fringe, floodway and river from the top of the escarpment. The entire Flood Fringe is accessible to the public. Good design will ensure recreational areas blend with the natural surroundings.
Social	Local Accessibility of Open Space	The scenario increases walkable access to open space in and around the Flood Fringe study area.	6.00	1	6	Open space in the Flood Fringe and floodway is walkable from adjacent benches and table lands, but the distance may be prohibitive for some residents of these areas.
Social	Regional Accessibility of Open Space	The scenario results in open space in or around the Flood Fringe study area that is supported by road access and some amount of public parking.	5.00	1	5	Open space in the floodway and Flood Fringe is accessible via road access and parking lot to the Flood Fringe and from the regional pathway.
Social	Provision of Open Space Amenities	The scenario provides open spaces that are appropriate for cultural uses, events, recreation, and celebration.	5.00	1	5	Recreational land uses and the amenity node may include these types of spaces.
Social	Human Impacts due to Flooding	The scenario minimizes the risk of damage and trauma resulting from floods.	10.00	-0.5	-5	There is no residential development in the Flood Fringe, however the area is not built out of the 1:100 year flood event. The scenario does not fully minimize the risk of damage and trauma resulting from floods because there is potential for large volumes of people to be using the area for recreation.
Economic	Land Value and Property Enhancement (Inside Boundaries)	The scenario captures and raises the monetary land value inside the study area.	7.00	0.5	3.5	Recreation and natural park areas may increase land value in the Flood Fringe and provide opportunities for leasing and commercial partnerships.
Economic	Land Value and Property Enhancement (Adjacent Land)	The scenario increases the monetary land value in surrounding areas.	7.00	1	7	Recreation and natural park areas in the Flood Fringe may increase the land value of adjacent benches and table lands. (Assumes escarpment provides some buffering for noise and traffic).
Economic	Infrastructure Flood Damage Costs	The scenario minimizes the risk of costs associated with infrastructure loss or damage from a flood.	10.00	-0.5	-5	Recreational infrastructure may be damaged in a 1:20 year flood event or higher.
Economic	Business and Tourism Development Impacts	The scenario supports business and tourism development in the Flood Fringe and adjacent lands.	5.00	1	5	Recreation park areas and the amenity node increase opportunities for business and tourism in the Flood Fringe and adjacent benches and table lands.
Economic	Total Cost - Public Land Acquisition	The scenario minimizes up-front cost related to public land acquisition (land is privately held).	7.00	-1	-7	This scenario has a high up-front public cost of land acquisition. Tax revenues may be generated by commercial recreation operations.
Economic	Total Public Cost - Development	The scenario minimizes up-front public costs related to site preparation, reclamation, or amenity development.	7.00	-1	-7	Natural park areas have moderate upfront public reclamation costs. Recreation areas have high up-front infrastructure costs.
		Totals	100	3.5	13.5	

6.5.1 S5 Triple Bottom Line

The Recreation and Nature Park Scenario will have moderate impacts to the escarpment, as recreational development will require raising the land to minimize flood risks to infrastructure, positive drainage for the stormwater pond, and fill for grading purposes. The restoration of the natural area will improve riparian quality and quantity, while moderately impacting wetlands along the escarpment and within the existing disturbed area. Social indicators score generally high, providing easy access to extensive high quality open space and improving the visual quality of the landscape, however potential human impacts during flooding events are likely to be high, given the increased regional use of the area. Economic indicators are varied, as the scenario carries with it a high infrastructure burden, improves land values within and around the study area, and requires large upfront public expense to purchase the area, restore the natural area, and develop the recreation area.

Given this information, the scenario resulted in ranking 2nd out of the 6 evaluated scenarios under current conditions, with a score of 13.5. Therefore, this level of the two-stage evaluation indicates, that under current conditions, the Recreation and Nature Park scenario is a worthy consideration.

Figure 63 View of the eastern Flood Fringe study area from the upper bench

S5: Recreation + Nature Park | Resiliency Test

		1.	2.	3.	
TBL Domain	Indicator	River Morph.	Climate Change	Econ. Decline	S5 Resilience Justification Statement
Environmental	Habitat and Water Management Along Escarpment	-1	-0.5	0	Changes to river morphology may result in increased erosion of the escarpment. Economic downturn may reduce fill needed for developed areas.
Environmental	Riparian Habitat	-0.5	1	0.5	Changes to river morphology may lead to the loss of natural area. Increased flooding events may lead to cottonwood recruitment.
Environmental	Wildlife Connectivity	-0.5	-0.5	0.5	Recreational areas may impede movement if natural lands are lost to changes in river morphology. Flooding events may disrupt movement corridors. Economic downturn may reduce recreational use and thus promote increased movement through the recreation areas.
Environmental	Wetland Quality and Quantity	-0.5	-0.5	0	Changes to river morphology, and increased flood volumes may impact wetlands.
Social	Aesthetic Appeal - Views into Site	-0.5	-0.5	-0.5	Changes to river morphology may result in loss of natural areas, and increased flooding events may lead to derelict houses in the residential area. Economic downturn may lead to derelict houses
Social	Local Accessibility of Open Space	0	1	1	Changes to river morphology may result in loss of natural areas and pathway systems.
Social	Regional Accessibility of Open Space	0.5	0.5	1	Changes to river morphology may lead to the loss of open space. Increased flooding events may impact regional pathways and parking lot access.
Social	Provision of Open Space Amenities	0.5	0.5	0.5	Changes to river morphology and flooding events may lead to the loss of natural and recreational areas. Economic downturn may preclude maintenance efforts.
Social	Human Impacts due to Flooding	-0.5	-0.5	-0.5	People making use of recreational amenities may be impacted by extreme flooding events.
Economic	Land Value and Property Enhancement (Inside Boundaries)	0	0	-0.5	Economic downturn may result in lack of upkeep of recreation area, resulting in derelict property/
Economic	Land Value and Property Enhancement (Adjacent Land)	-0.5	-0.5	-1	Economic downturn may result in lack of upkeep of recreation area, reducing value of nearby property.
Economic	Infrastructure Flood Damage Costs	-1	-0.5	-1	Built infrastructure may be damaged or lost due to shifts in river morphology. Extreme flooding events may damage stormwater, recreational areas, or natural areas. Economic downturn may make infrastructure upkeep prohibitive.
Economic	Business and Tourism Development Impacts	0	0	0.5	Changes to river morphology and extreme flooding events may lead to loss or damage to recreational amenities. Economic downturn may reduce profit of commercial recreation activities.
Economic	Total Cost - Public Land Acquisition	-1	-1	-1	
Economic	Total Public Cost - Development	-1	-1	-1	
	Total:	-46.5	-21.5	-19.5	

No change observed from Triple Bottom Line.

6.5.2 S5 Resilience

6.5.2.1. River Morphology

Potential changes to river morphology may see the loss of the natural area, and potentially the recreation area as well. Riparian habitat will likely be lost as the river meanders.

Score: -46.50
Rank: 6 out of 6

6.5.2.2. Climate Change

Increased flooding events due to climate change will likely see increased cottonwood establishment in disturbed lands. Increased flooding events will likely lead to human impacts, due both to the presence of regional parking (leading to extensive use of both the recreation and riparian areas) and the attractive draw of regional recreation facilities.

Score: -21.50
Rank: 4 out of 6

6.5.2.3. Economic Decline

Potential economic downturn may impact the sustainability of the recreation area, which in turn may impact property values of the adjacent lands should the upkeep of the area falter. Furthermore, poor economic conditions may compromise the intended business plan of commercial development in the area. Infrastructure costs will likely increase under both climate-driven flood increases, and from changes to the river morphology.

Score: -19.50
Rank: 5 out of 6

6.5.3 S5 Summary

From the initial stage of the indicator framework, the Recreation and Nature Park scenario ranked 2nd, indicating that it could present as a reasonable development option. However, when placed under the second stage of the assessment, the Resilience Test, this scenario ranked in the bottom half of the scenarios in all three tests. This indicates that while the scenario may seem like a good choice given current knowledge and understanding, it is not able to withstand the stress of potential future change. This scenario may become a risk in the future due to it's fragility in the face of potential change.

		S5	Rank
	TBL Analysis	13.5	2/6
Resilience Test	River Morphology	-46.5	6/6
	Climate Change	-21.5	4/6
	Economic Decline	-19.5	5/6

Figure 64 Current access road to the existing farmhouse.

6.6 Scenario 6: Full Residential Build Out

Scenario 6 (S6): Full Residential Build Out maximizes the residential development potential, filling the entire study area north of the 200 year meander belt with residential use. The adjacent natural park enables river access via trails and establishes a natural amenity for the residents, acting as a social benefit for this scenario. There will be public access to the site through the roads into the residential area, and the planned regional pathway, however this scenario assumes no additional public parking lot.

This scenario has the largest developed footprint, and therefore uses the most engineered fill, raising the entire developable area by 5 metres. This maximizes the buildable area and reduces the risk to human safety from a 1:100 year flood event, however, causes a greater disturbance to the natural ecology and wildlife by pushing wildlife movement into the floodway and along the river, and potentially constricting the riparian habitat in the Flood Fringe. The increased number of residents may cause disturbances to wildlife and natural habitats in the area. The anticipated environmental benefits are minimal in this scenario. However, at maximum build-out, it can be assumed that this scenario retains a stronger economic benefit.

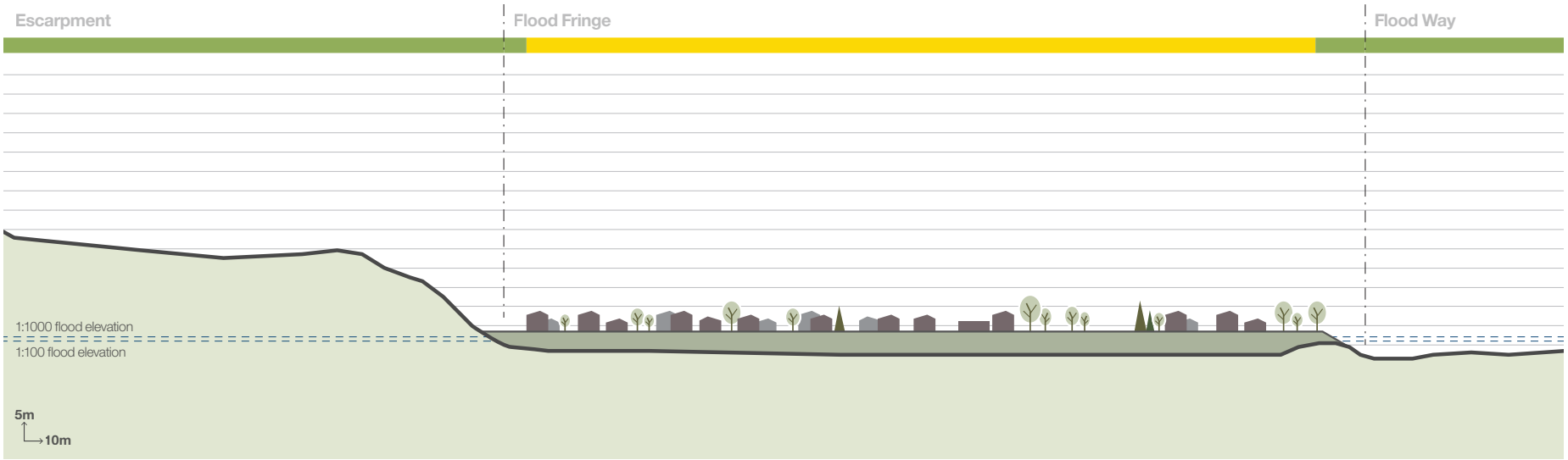
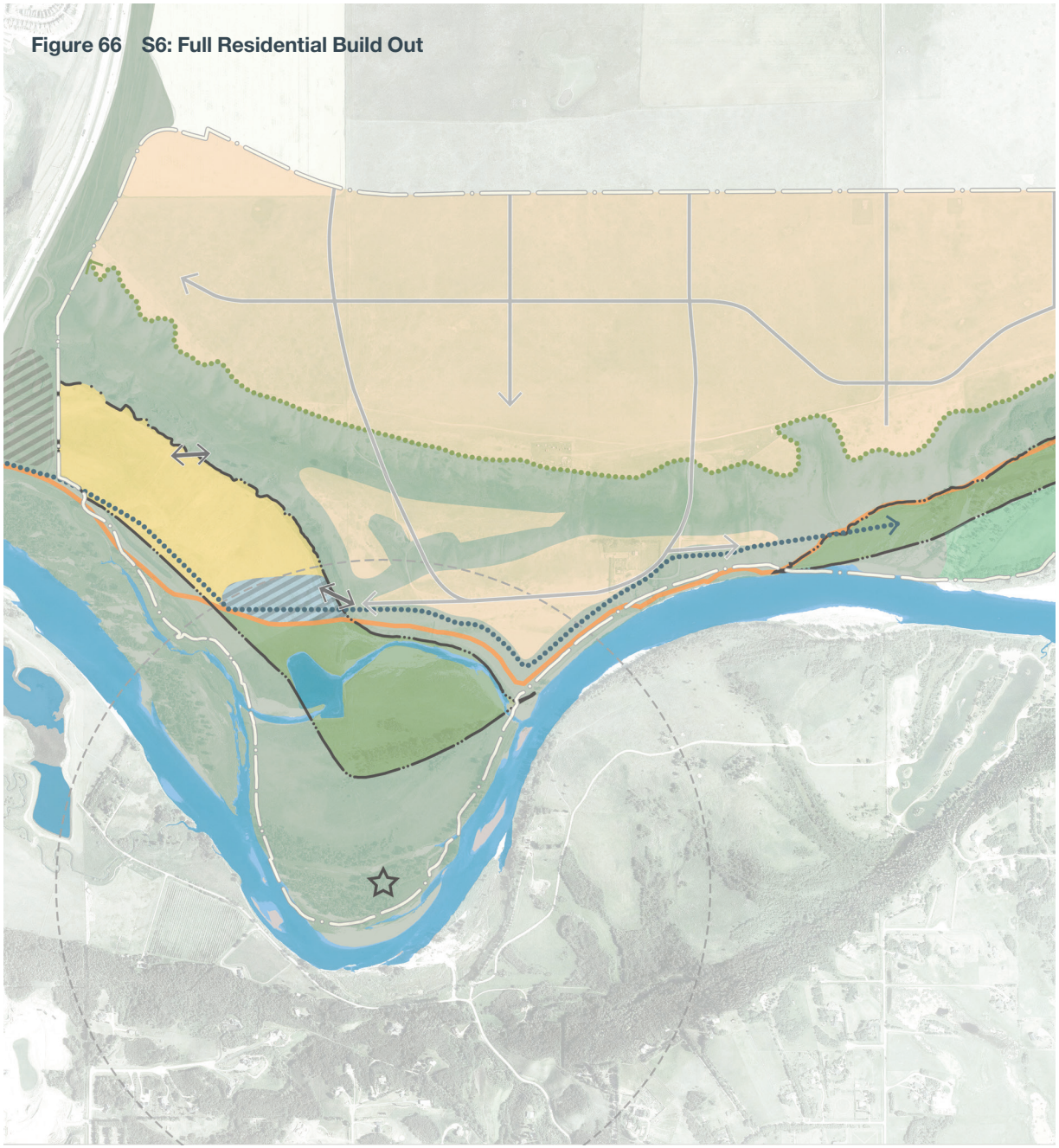


Figure 65 Illustrative section of S6: Full Residential Build Out.

Figure 66 S6: Full Residential Build Out



S6: Full Residential Build Out | Triple Bottom Line

TBL Domain	Indicator	Desired Performance	Weight	S6 Score	S6 Weighted	S6- Justification Statement
Environmental	Habitat and Water Management Along Escarpment	The scenario has a positive impact on the ecological performances of the escarpment, including provision of habitat and water management.	7.00	-1	-7	5m of fill added along the escarpment.
Environmental	Riparian Habitat	The scenario improves the quality or amount of riparian habitat.	7.00	-0.5	-3.5	No increase in riparian habitat. Increased development leading to increased activity in existing riparian habitat.
Environmental	Wildlife Connectivity	The scenario improves wildlife movement through the river valley corridor.	7.00	-0.5	-3.5	Reduced connectivity through the riparian area, coupled with reduced connectivity towards the escarpment.
Environmental	Wetland Quality and Quantity	The scenario improves the quality or amount of wetlands.	4.00	-0.5	-2	Loss of existing wetlands in Flood Fringe and escarpment, newly constructed naturalized stormwater wetland.
Social	Aesthetic Appeal - Views into Site	The scenario provides high quality views into the site from publicly accessible locations around the study area (the escarpment and the highway).	6.00	-0.5	-3	Views into the Flood Fringe are not improved due to limited natural areas. Residential development has the potential to block views to the river from the escarpment.
Social	Local Accessibility of Open Space	The scenario increases walkable access to open space in and around the Flood Fringe study area.	6.00	0.5	3	Open space in the floodway is walkable for residents in the Flood Fringe and adjacent benches and table lands. Open space in the Flood Fringe is limited due to residential development.
Social	Regional Accessibility of Open Space	The scenario results in open space in or around the Flood Fringe study area that is supported by road access and some amount of public parking.	5.00	0	0	Open space in the floodway is accessible via road access to the Flood Fringe. Private residential development does not support public facilities (e.g. parking, washrooms).
Social	Provision of Open Space Amenities	The scenario provides open spaces that are appropriate for cultural uses, events, recreation, and celebration.	5.00	0	0	Residential land uses may include these types of spaces. This scenario includes less open space that could accommodate these types of uses.
Social	Human Impacts due to Flooding	The scenario minimizes the risk of damage and trauma resulting from floods.	10.00	0	0	Assuming the residential area is built outside of the 1:100 year flood event, the risk of flood impacts for flood events at the 1:100 level and under is neutral.
Economic	Land Value and Property Enhancement (Inside Boundaries)	The scenario captures and raises the monetary land value inside the study area.	7.00	1	7	Low density residential housing by the river increases the land value in the Flood Fringe.
Economic	Land Value and Property Enhancement (Adjacent Land)	The scenario increases the monetary land value in surrounding areas.	7.00	0	0	Vehicular access into the Flood Fringe increases neighbouring land values. Residential areas in the Flood Fringe limit the available amenities for residents.
Economic	Infrastructure Flood Damage Costs	The scenario minimizes the risk of costs associated with infrastructure loss or damage from a flood.	10.00	0.5	5	Assuming the residential area is built outside of the 1:100 year flood event, the risk of flood impacts is reduced.
Economic	Business and Tourism Development Impacts	The scenario supports business and tourism development in the Flood Fringe and adjacent lands.	5.00	-0.5	-2.5	There are limited opportunities for business and tourism in the Flood Fringe.
Economic	Total Cost - Public Land Acquisition	The scenario minimizes up-front cost related to public land acquisition (land is privately held).	7.00	1	7	Residential development on the edge of the city has a public carrying cost above taxes generated. However, there are minimal up-front public costs in this scenario.
Economic	Total Public Cost - Development	The scenario minimizes up-front public costs related to site preparation, reclamation, or amenity development.	7.00	1	7	No up-front public reclamation costs are required, and low up-front infrastructure costs will likely be balanced against tax revenues.
		Totals	100	0.5	7.5	

6.6.1 S6 Triple Bottom Line

A Full Residential Build Out Scenario will see overall compromise to the ecological function of the area, as the extensive fill required for development will impact the escarpment lands, compromise connectivity, and lead to the loss of riparian and wetland habitat. Social values are only somewhat improved from the baseline, due to the local access to the river lands. The economic values however, are by and large improved by the extensive residential development, leading to a maximization of land value within the area, and removing any cost to the public for acquisition or development of the area.

The Full Residential Build Out scenario received a cumulative score of 7.5, achieving a ranking of 3rd out of the 6 evaluated potential Flood Fringe development scenarios.

Figure 67 Existing riparian vegetation south of the western Flood Fringe study area.

S6: Full Residential Build Out | Resiliency Test

		1.	2.	3.	
TBL Domain	Indicator	River Morph.	Climate Change	Econ. Decline	S6 Resilience Justification Statement
Environmental	Habitat and Water Management Along Escarpment	-1	-1	-1	Changes to river morphology and increased flooding events may result in increased erosion of the escarpment. Economic downturn may reduce fill needed for developed areas.
Environmental	Riparian Habitat	-1	-0.5	-0.5	Changes to river morphology may lead to the loss of riparian habitat around the stormwater infrastructure. Economic downturn may lead to reduced use of the existing riparian areas.
Environmental	Wildlife Connectivity	-1	-0.5	-0.5	Changes to river morphology may cause a funneling effect, forcing wildlife movement through the residential area. Economic downturn may lead to fewer residents, and fewer vehicle trips through the area.
Environmental	Wetland Quality and Quantity	-1	-1	-0.5	Changes to river morphology and increased flood volumes have potential impacts to constructed wetlands.
Social	Aesthetic Appeal - Views into Site	-1	-0.5	-1	Changes to river morphology and increased flood damage may damage homes and neighbourhoods. Economic downturn may lead to derelict homes.
Social	Local Accessibility of Open Space	-0.5	0.5	0.5	Changes to river morphology may impact roads and local trails.
Social	Regional Accessibility of Open Space	-1	0	0	Changes to river morphology may impact road access into the neighbourhood, and damage the regional pathway infrastructure.
Social	Provision of Open Space Amenities	-0.5	0	0	Changes to river morphology may impact neighbourhood parks.
Social	Human Impacts due to Flooding	-1	-1	0	People living in the residential development area may be impacted by extreme flooding events and loss of land due to shifts in river morphology.
Economic	Land Value and Property Enhancement (Inside Boundaries)	1	1	0.5	Low density suburban housing market may be compromised by economic downturn.
Economic	Land Value and Property Enhancement (Adjacent Land)	0	0	-0.5	Economic downturn may make large isolated lots less saleable, reducing value of nearby property.
Economic	Infrastructure Flood Damage Costs	-1	-1	0.5	Changes to river morphology and increased flood volumes have potential impacts to infrastructure
Economic	Business and Tourism Development Impacts	-0.5	-0.5	-0.5	
Economic	Total Cost - Public Land Acquisition	1	1	1	
Economic	Total Public Cost - Development	1	1	1	
	Total:	-43	-19.5	-2.5	

No change observed from Triple Bottom Line.

6.6.2 S6: Resilience

The extensive development of the area leads to a heightened risk of impact due to shifts in river morphology and increased flooding events, which will increase the potential human and infrastructure risk should a large-magnitude / low-probability disaster occur during the lifetime of the development.

6.6.2.1. River Morphology

Score: -43.00
Rank: 5 out of 6

6.6.2.2. Climate Change

Score: -19.50
Rank: 3 out of 6

6.6.2.3. Economic Decline

Score: -2.50
Rank: 2 out of 6

6.6.3 Summary

The Full Residential Build Out scenario ranks 3rd out of the 6 evaluated potential Flood Fringe development scenarios, when assessed under the TBL. This analysis indicates that the majority of the economic indicators are partially or fully supported, environmental indicators are undermined, and the majority of social indicators receive a neutral score. This indicates that this scenario does not achieve a balanced TBL result.

When analyzed through the resilience lens, this scenario ranks in the top half of the scenarios in Resilience to Climate Change and Economic Decline. However, this scenario falls to 5th for Resilience to River Morphology. The majority of the supportive indicators remain in the economic domain, highlighting an imbalance in the scenario.

		S6	Rank
	TBL Analysis	7.5	3/6
Resilience Test	River Morphology	-43	5/6
	Climate Change	-19.5	3/6
	Economic Decline	-2.5	2/6

Figure 68 View of the riparian vegetation of the eastern Flood Fringe study area, and natural beach in the floodway.

Figure 69 View of the original farmhouse in the Ricardo Ranch study area.

7 Conclusion

Each of the 6 potential Flood Fringe development scenario was evaluated using the established two-stage indicator framework, the results of which are outlined in the table and below.

7.1 Triple Bottom Line Analysis

Each scenario scores differently when run through the TBL analysis, with each scenario presenting a variety of strengths and weaknesses. From the initial TBL analysis, the following scenarios received the top three scores:

1. **The Nature-Residential Hybrid**
2. **The Recreation + Nature Park**
3. **The Full Residential Build-Out**

The Nature-Residential Hybrid and Recreation + Nature Park scenarios score somewhat similarly in all three domains (Environmental, Social and Economic). However, the Nature-Residential Hybrid scores slightly lower in the Environmental domain. This is due to the higher levels of disturbance that would be caused by the placement of 5m of fill in the residential area as well as the anticipated negative impacts on riparian habitat and wildlife movement in the Flood Fringe and floodway. In contrast, the Recreation + Nature Park scenario scores slightly higher in the Environmental domain because it requires lower levels of fill and a smaller extent of development to support recreational use in the Flood Fringe. However, the Environmental score for the Recreation + Nature Park scenario is still relatively low when compared to other scenarios because recreational use would result in higher intensities of human activity and and would require road access, impacting wetlands, riparian habitat and wildlife movement in the Flood Fringe and floodway.

Both Nature-Residential Hybrid and Recreation + Nature Park score relatively high in the Social domain because they support local and/or regional access to the river and open space, including riparian areas. They also create opportunities to increase social capital, providing spaces for cultural uses, events, recreation, and celebration close to residential development in natural areas and more formalized neighbourhood parks.

		S1	S2	S3	S4	S5	S6
	TBL Analysis (score)	-22.0	-0.5	18.5	-6.5	13.5	7.5
Resilience Test	River Morphology (score)	-32.0	-39.5	-24.5	-34.5	-46.5	-43
	Climate Change (score)	-25.5	-15.0	-16.0	-35.0	-21.5	-19.5
	Economic Decline (score)	-22.0	-2.5	2.0	-16.5	-19.5	-2.5

Nature-Residential Hybrid scores higher than Recreation + Nature Park in the Economic domain because residential development in that scenario is privately funded, while the recreational development would be publicly funded, requiring tax-payers to pay high up-front land acquisition and development costs.

7.1.1 Why These Scenarios?

1. **The Nature-Residential Hybrid** scored the highest because it takes a more balanced approach to development, utilizing a natural buffer at the edge of the Flood Fringe to provide spaces for social gathering and recreation, to improve views into the site and to mitigate some of the environmental impacts caused by residential development in the Flood Fringe.
2. **The Recreation + Nature Park** received a relatively high score because the environmental impacts associated with natural recreation areas are potentially less damaging than those caused by residential development in the Flood Fringe. However, because this scenario must be fully funded by public tax dollars, its Economic score and overall performance in the TBL analysis suffers.
3. **The Full Residential Build-Out** scenario scored in the top three scenarios of this TBL analysis based on the Economic benefit of being privately funded. The Social benefits of bringing people closer to the river for recreation and cultural uses also improved the scenario's relative score.

7.2 Resilience Test

The resilience test evaluated how well a scenario might function under the stress of changes due to River Morphology, Climate Change and Economic Decline. These tests highlighted the areas of fragility for the scenario and the anticipated inherited risks the scenario might contain.

As illustrated in the table above, the Nature-Residential Hybrid scenario remains in the top two scenarios throughout the resilience assessments. This ranking indicates that the overall indicator balance achieved by this scenario increases its resiliency. The incorporation of the natural park increases the resilience of the natural space through increased vegetation cover and acts as a protective buffer for the residential area.

The Recreation + Nature Park Scenario falls from ranking second under the initial TBL to the bottom half of all the scenarios during the resilience tests, indicating the relative fragility of this scenario. The requirement for less fill for development, resulting in a lower ground elevation in recreation areas, contributes to its vulnerability in all three domains. Additionally, as the entire scenario is publicly funded, the economic indicators are either fully or partially undermined in the resiliency test.

The score for the Full Residential Build Out scenario is affected by all three resilience tests. The scenario is ranked higher under the Economic Decline test. This may be attributed to the reduced public costs of land acquisition and development, increasing the economic viability of this scenario in an economic downturn. Both the Social and Environmental indicators are mainly undermined throughout the resilience testing due to the extent of residential development in this scenario.

7.2.1 Risks Inherited by the Top 3 Scenarios

Areas adjacent to the river that are used by humans (both residential and recreational areas) are subject to risks from natural disasters, including flooding and river morphological changes. These include direct and immediate risks to human safety as well as longer-term impacts to residents related to loss of power and utilities. The risk also includes the potential costs of responding to an emergency and evacuating residents. These risks vary depending on the type and location of development, the mitigation measures and risk management practices put in place, and the type and intensity of human use, among other factors. In general, planning for residential or recreational use in the flood fringe inherits a degree of risk to human safety.

Infrastructure is also at risk of damage from natural disasters, including flooding, and river morphological change. The risk of infrastructure damage or loss and the cost associated with its repair is a major consideration when establishing development within the flood fringe.

Flooding and river morphology may also erode river banks and impact bank stability near development in the flood fringe area, which may also compound risks to human safety. In addition to bank stability, slope stability along the escarpment should also be considered over time. Seepage from the slope springs may increase as storms become more severe due to climate change. Development on the upper benches and table lands may also result in greater amounts of runoff along the escarpment slopes, potentially impacting soil stability.

Climate change may result in additional impacts to the scenarios, including increased temperatures, and increased severity of storms, that may impact the health of the riparian vegetation in natural areas. However, it is anticipated that increased flooding may help in the establishment of the balsam poplar forest in riparian areas.

In terms of economic decline, development of any kind is subject to market fluctuation. The success of these scenarios is dependent on market demand which may or may not change in the face of an economic decline. Residential development in this location may be disproportionately impacted by economic decline because of its location and the cost of housing units. Publicly funded land uses may be heavily impacted by economic decline due to the cost of land acquisition and maintenance, which would be funded by a potentially lower tax base.

7.3 Ricardo Range Flood Fringe Study Summary

The two-stage assessment framework allowed the Ricardo Ranch Flood Fringe Study to analyze 6 different potential development scenarios through both a present-day and future lens. The initial Triple Bottom Line assessment indicates the top three scenarios that, according to current knowledge and understanding, perform the best. The Resilience tests then put those top three scenarios through an evaluation based on potential future changes, including climate change, river morphology, and economic decline. This second step in the assessment highlighted the potential risks associated with each scenario moving forward, establishing a better understanding of the long-term vitality of these potential development scenarios for the Ricardo Ranch Flood Fringe.

What can be concluded from this process is that a more balanced approach to preservation and development has a higher level of success in the TBL and Resilience assessments:

- A mix of public and private funding tends to achieve a higher score because it reduces public cost while increasing public benefit, including increased access to open space, access to the river, provision of recreational and cultural opportunities and more.
- Natural areas and more limited development may be more resilient in the face of morphological changes to the river and increased frequency and severity of flooding. This is due to the reduction in risk to human safety and damage to infrastructure.
- Additionally the development of a healthy riparian ecosystem in the natural areas helps to establish a increased level of natural protection from erosion and flooding. These buffer created by these spaces may reduce the short and long-term impacts of flooding.

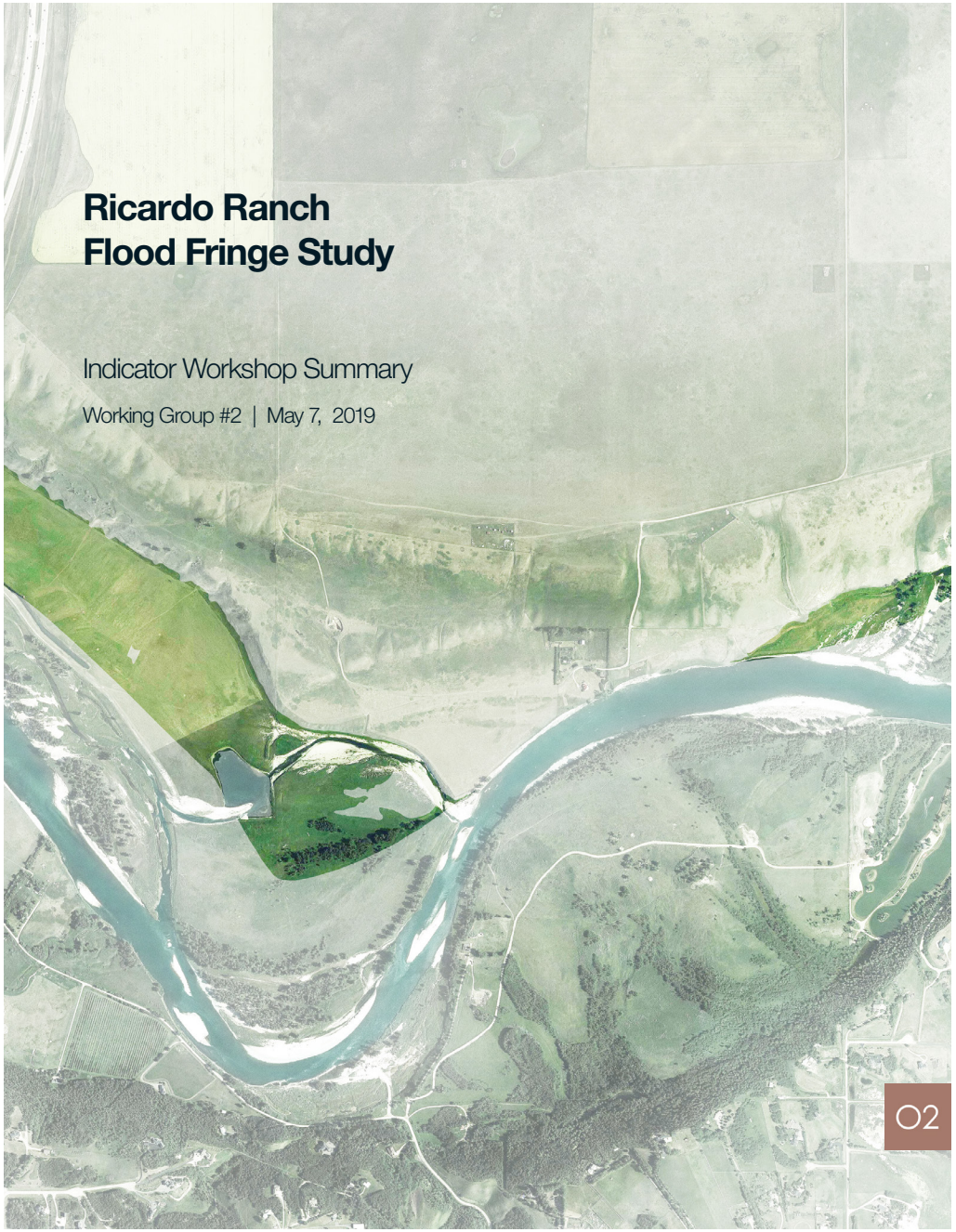
The scenario that faired the best in the TBL and Resilience assessments balanced the three domains, environmental, social, and economic, and in so doing, increased its overall resiliency. The risks highlighted from the resilience assessments may direct the type and intensity of mitigation measures and risk management practices that should be considered.

This study emphasizes the importance of evaluation from both a short and long-term perspective, understanding that the risks highlighted during the resilience assessments are real, and should be taken seriously moving forward.

Figure 70 View of the dug out and riparian vegetation of the eastern Flood Fringe study area, looking southeast.

Figure 71 View of the dug out and riparian vegetation, looking southeast

8 Appendix A: Working Group Summaries



02 Ricardo Ranch Flood Fringe Study

Ricardo Ranch Flood Fringe Study

Project Purpose

The Ricardo Ranch Flood Fringe Study convenes stakeholders to help establish and evaluate land use scenarios for the flood fringe of Ricardo Ranch, an area along the Bow River in southeast Calgary. The study will recommend a resilient land use profile for the site that balances environmental, economic, and social outcomes.

Working Group #2: Indicator Workshop

The second Working Group meeting, referred to as the "Indicator Workshop", took place on May 7, 2019. Over fifteen participants from key stakeholder groups attended the session. The main purpose of the workshop was to gather information to ground the next phases of the Ricardo Ranch Flood Fringe Study. To do this, the workshop was divided into three main tasks:

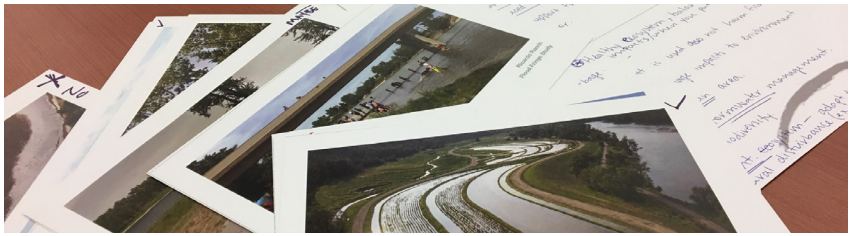
1. To establish a "Palette of Uses" that will comprise the Ricardo Ranch scenarios.

2. To define success in the Triple Bottom Line (TBL) domains (social, economic, and environmental), that will be used to assess the Ricard Ranch scenarios.

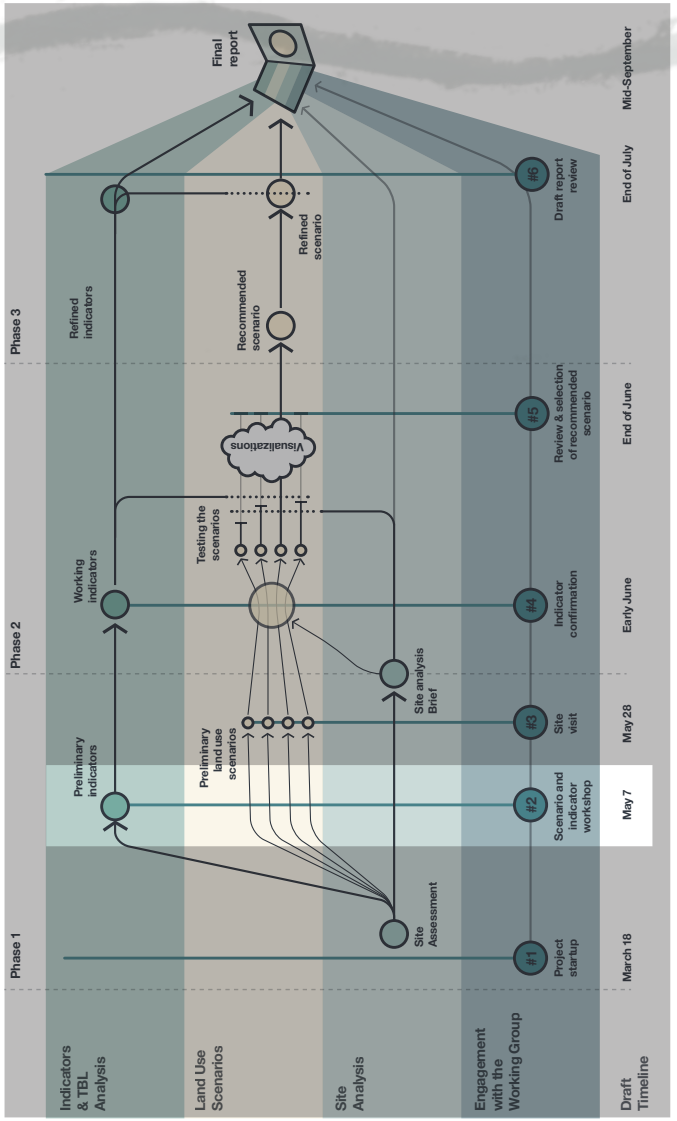
3. To produce and prioritize a collection of indicators that the study can use to determine the success of the produced scenarios across the three domains.

The three questions were explored through guided small-team exercises. Participants were organized into four groups, each of which captured a mix of stakeholder positions and expertise. These groups periodically shared back their conversations to the broader group. This arrangement helped provoke meaningful debate and conversation at each table, while allowing the Project Team to draw on the full range of perspectives in the room.

The information gathered from this workshop has been reviewed and is outlined in the following summary.



Project Workflow



Indicator Workshop

Exercise A: Palette of Uses

In the first exercise, the working group was presented with a set of potential uses that could comprise future scenarios on the Flood Fringe site. The task was to narrow the potential uses to those deemed most viable and appropriate for the site, to be included in a working palette. Attendees were encouraged to keep, modify, and/or disregard the uses provided, as well as create additional uses. If a use was disregarded, attendees were asked to provide some justification to record the reason behind its removal.

Through this exercise, the groups came to a mostly common agreement regarding a palette of uses to consider for the Ricardo Range Flood Fringe Study. The results of the conversation are summarized on the following pages.

Discarded Uses + Programs:

High Intensity Recreation

- Not likely at this intensity
- Negative environmental impacts
- Not development funded
- Heron setbacks makes this unlikely

Private Recreation

- No demand, market analysis required, no financial sense
- Not large enough
- Negative environmental impact

Institutional

- No demand, school siting already placed
- Not at this intensity or scale
- Major restrictions for any provincially funded institutional developments within floodplains

Unconfirmed/Debated Uses + Programs:

Low-Profile Apartments

- Market may not support this use in this area
- Potential, yet unlikely

Unaltered (agricultural use)

- Current use not viable in the long term
- Temporarily allowable
- Potentially the “least useful use”

Grand Gateway Park

- The river is the image of Calgary

Uses & Programs to Be Considered in Scenarios:

Low Density Residential

- Similar to Cranston
- A mixture of housing types should be included in all scenarios [low density, semi-detached/town homes, low profile apartments].

Semi-Detached / Town Homes

- A mixture of housing types should be included in all scenarios [low density, semi-detached/town homes, low profile apartments].

Stormwater Management

- Constructed wetlands and/or stormwater pond facilities
- Gravity drainage (vs pumped)
- Potential to integrate a range of opportunities [recreation, views, trails, aesthetic asset, etc]

Restored Natural Areas

- Preserve natural areas, and restore outside of development area
- Protect wildlife routes
- Restore natural areas in the east, and construct natural areas in the west
- Potential to combine with all development opportunities

Commercial

- Small scale only, low intensity
- Consider river access strategy

Low Impact Recreation (Trails)

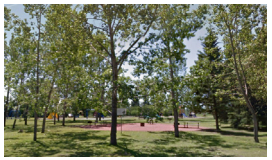
- Good option in the floodway

Pedestrian River Access (rafts, fishing, etc)

- Potential access through the Environmental Reserve
- Requires appropriate take out point

Vehicular Access Boat Ramp

- Requires appropriate take out point
- Location will present an issue, consideration of accessory infrastructure (road, parking, washrooms, etc.) present complications.
- Grading will be an issue



Public Park / Day Use Area

- Work well from a flood risk perspective, may cause environmental damage
- Dog parks, pathway + trail connections

Exercise B: Defining Success

As a step toward setting out project indicators, the working group ran through an exercise where they were tasked with defining success in each of the three TBL domains. This was undertaken to help frame the indicator conversation: before we ask 'what to measure?', we need to ask 'what to measure for?'.

Each group was provided with a form that they used to gather notions of what TBL success might look like for the site. All groups found moments of consensus, overlap, and divergence. Many groups agreed that **flood safety, accessibility**, and the **establishment of a destination** provided indications of social success. **Profitability**, and the provision of **affordable housing** options were shared notions of economic success between groups. Effective **stormwater management**, protection of a **healthy ecosystem**, and a **resilient environment** were shared indications of environmental success. Detailed results from this exercise are summarized in the charts to the right.

Social Success

Group 1	Group 2	Group 3	Group 4
» Access: bringing people to celebrate the area » Combination of public + private access	» Defined + managed public access point to the river + other amenities » Access to natural amenities. » Access to a diversity of housing options + costs » Universal access (for people of all abilities) to the water where possible » Establishment of a strong community fabric	» Flood safety + resilience. » Establish a local amenity for ASP residences » Establish a destination attraction for the City of Calgary » Incorporate slope development (Ex. Mountain bike trails in stable areas, tobogganing opportunities). » Playgrounds in the flood fringe » Active Alberta + Sport for Life	» No future flood risk for people 2-500 year risk » Community is internally connected, with quality access to services » Establish a Gateway for Calgary » Establish a pedestrian + bicycle friendly network » Public access to views, the river, and open space

Economic Success

Group 1	Group 2	Group 3	Group 4
» Provision of affordable housing options » Access + development must be economically feasible + profitable » Establishment of a complete community	» A resilient built environment » Development is profitable » Reduced number of people displaced by natural disturbances +/or flood events » Minimal costs associated with flood events (long-term success)	» Viable + profitable business for developer » Property tax benefit. » Reduction of future liabilities » Comparison of risk to existing developments » Dollars per front foot	» Cost neutral in development costs, regarding life-safety » Economically viable » Valuable land allows for affordable housing elsewhere » Meets market demand

Environmental Success

Group 1	Group 2	Group 3	Group 4
» Ensure flood resiliency » Protect sensitive wildlife » Preserve environmentally significant features » Preserve ecological connections	» A health, balanced ecosystem that includes human use » Overall biodiversity » A healthy riparian area » Effective stormwater management » Resilient ecosystem, that can adapt + respond positively to natural disturbance	» Stormwater design for water quality and multifuncitonality » Biodiversity, maintain habitats + connections » Side channel has potential for long term fish habitat offsets	» Commits to Riparian Action Plan, biodiversity, + maintain wildlife movement » Stormwater is effectively manged, aspire to mitigation of all flood impacts

Exercise C: Indicator Brainstorm

Indicators will provide the Project Team with a set of metrics that can be used to assess various land use scenarios for the project site. Ultimately they will provide a measure of how each scenario impacts its TBL domains. In the final workhop exercise, groups were provided with a working set of indicators. They were tasked with selecting, discarding, creating, and prioritizing these indicators.

First, groups ranked their set of indicators in order of perceived importance within each domain. Once this arrangement was complete, each group was given 50 tokens and asked to 'spend' them across all indicators.

The "Total Cost" indicator was assigned the highest weight among the listed indicators for all groups, though it is worth noting that other economic indicators were commonly seen as falling within this metric. Detailed results from this exercise are summarized in the charts to the right.

Preliminary Ranking of Social Indicators

Rank	Group 1	Group 2	Group 3	Group 4
1	Developable area within walkable (500m) access to parkland.	Emergency access: Protect connectivity and ease of access + departure during flooding or other emergencies/disasters.	Total park area that can accommodate cultural uses, events, + celebration. (4-season).	Emergency access: Protect connectivity and ease of access + departure during flooding or other emergencies/disasters.
2	Developed area within walkable (500m) access to river.	Developed area within walkable (500m) access to river.	Developed area within walkable (500m) distance of a transit stop or station.	Life safety - flood risk. (life safety risk for extreme events beyond 1:100 + 1:200 year design considerations).
3	Accessibility (maintains or enhances accessibility and recreation opportunities).	Length of pathways + trails.	Emergency Access: Disaster response + safety.	Developed area within walkable (500m) access to river.
4	Total park area that can accommodate cultural uses, events, + celebration. (Developed park area)	Accessibility (maintains or enhances accessibility and recreation opportunities).	Total publicly accessible area with scenic views (to water or parkland).	Accessibility (maintains or enhances accessibility and recreation opportunities).
5	Total publicly accessible area with scenic views (to water or parkland).	Developable area within walkable (500m) access to open space.	Accessibility (maintains or enhances accessibility and recreation opportunities).	Developable area within walkable (500m) access to parkland.
6	Developed area within walkable (500m) distance of a transit stop or station. (If transit is provided).	Total publicly accessible area with scenic views (to water or parkland).	Developable area within walkable (500m) access to parkland.	Developed area within walkable (500m) distance of a transit stop or station.
7			Winter attractions.	Total publicly accessible area with scenic views (to water or parkland).
8				Total park area that can accommodate cultural uses, events, + celebration.

Preliminary Ranking of Economic Indicators

Rank	Group 1	Group 2	Group 3	Group 4
1	Total Cost.	Total cost/benefit ratio (long-term).	IBI Flood damage model.	Total Cost.
2	Private return on investment. Public return on investment (creation of jobs, tax base, developed public infrastructure/ amenities).	Private return on investment.	Total length of required infrastructure.	Gross units per hectare.
3	Total housing yield.	Total development yield. (Encompasses gross units per hectare + population density).	Total developable area with scenic views to water or parkland.	Total development yield.
4	Gross units per hectare.	Total volume of soil needed to raise developed area to regulated height-above-water.	Total development area near amenities/ parkland (see City Website).	Total development area around amenities with scenic views (to water or parkland).
5	Population density (assuming more is better).	Total length of required infrastructure.	Total development cost.	Private return on investment.
6	Estimated jobs per hectare (assuming more is better).	Total developable area with scenic views to water or parkland.	Operational/ Upkeep costs.	Total volume of soil needed to raise developed area to regulated height-above-water.
7	Total length of required infrastructure.			Servicing costs (infrastructure + operations).
8	Total volume of soil needed to raise developed area to regulated height-above-water.			Equivalent annual flood damage (including groundwater).
9	Total developable area with scenic views to water or parkland.			Total length of infrastructure required.

Preliminary Ranking of Environmental Indicators

Rank	Group 1	Group 2	Group 3	Group 4
1	Total area of open space (assuming more is better).	Adaptability, environmental resilience, and the inclusion of adaptive management strategies.	Total permeable surface area.	Wildlife movement area retained (connectivity/ habitat quality).
2	Total permeable surface area.	Biodiversity, measured in typical vegetation communities and habitat types.	Total area of open space.	Area maintained with natural cover (habitat quality and value).
3	Total length of undisturbed drainage paths.	Total area of open space (assuming more is better).	Total length of undisturbed drainage paths.	Number of species nests or habitat observations within undeveloped land.
4	Area restored to natural cover.	Area restored to natural cover.	Area restored to natural cover + area of constructed habitat.	Area of retained wetlands/wet areas.
5	Number of species nests or habitat observations within undeveloped land. Indicator of biodiversity (broaden this indicator).	Area of constructed wetlands. (Changed from “retained” wetlands).	Area of retained wetlands.	Total length of undisturbed drainage paths.
6	Area of retained wetlands. (Potentially less important of an indicator due to provided compensation for downstream wetlands).	Number of species nests, dens, or wildlife observations within undeveloped. (Recommend identification of key indicator species and tracking changes over time).	Number of species nest or habitat observations within undeveloped lands: biodiversity.	Total permeable surface area.
7		Total length of undisturbed drainage paths.	Connectivity.	Water quality.
8				Area of native grassland retention.
9				Total area of open space (assuming more is better).

Weighted Indicators

	Indicator	Group 1	Group 2	Group 3	Group 4	Total
Social Indicators	Developed area with walkable (500m) to river.	7	2	0	4	**13**
	Developable area with walkable (500m) access to parkland/open space	6	2	1	1	**10**
	Accessibility: maintains or enhances accessibility and recreation opportunities	3	2	1	4	**10**
	Emergency Access: Protect connectivity and ease of access and departure during flooding, or other emergencies/disasters, fire access, and level of service times	0	4	3	1	**8**
	Total park area that can accommodate cultural uses, events, 4-seasons, and celebration.	3	0	3	0	**6**
	Total publicly accessible area with scenic views (to water or parkland).	3	2	1	0	**6**
	Winter attractiveness to the area: lighting, warming huts, linear parks, temporary skate pathway, stormwater usage, cougar ridge hockey	0	0	4	0	**4**
	Length of pathway/trail	0	2	0	0	**2**
	Life safety- flood risk: life safety risk for extreme events beyond 1:100 and 1:200 year design level should be considered	0	0	0	2	**2**
	Developed area within 500m (5 minute walking distance) of a transit stop or station.	0	0	0	0	**0**
Economic Indicators	Total Cost	7	12	7	5	**31**
	Private Return on investment	3	6	0	4	**13**
	Public return on investment: create jobs, tax base, develop public infrastructure/amenities	7	0	0	0	**7**
	Operational / Upkeep Costs + Servicing Costs	0	0	3	3	**6**
	IBI Flood Damage Model	0	0	5	0	**5**
	Total development area near amenities/parkland (see City website)	0	0	5	0	**5**
	Equivalent annual flood damage (including groundwater)	0	0	0	3	**3**
	Total volume of soil needed to raise developed area to regulated height-above-water	0	0	0	2	**2**
	Total Development Yield	0	0	0	2	**2**
	Total developable area with scenic views (to water or parkland)	0	0	1	0	**1**
	Total housing yield	0	0	0	0	**0**
	Gross units per hectare	0	0	0	0	**0**
	Population density (assuming more is better)	0	0	0	0	**0**
	Estimated jobs per hectare (assuming more is better)	0	0	0	0	**0**
	Total length of required infrastructure	0	0	0	0	**0**
Environmental Indicators	Area restored to natural cover: area of constructed habitat	0	1	4	5	**10**
	Number of species nest or habitat observations within undeveloped lands: biodiversity	4	0	2	4	**10**
	Adaptability: adaptive management + environmental resilience	0	13	0	0	**10**
	Total area of open space (assuming more is better)	6	3	0	0	**9**
	Area of retained/constructed wetlands	0	1	2	5	**8**
	Total permeable surface area	1	0	4	0	**5**
	Wildlife movement area retained (connectivity/habitat quality)	0	0	0	5	**5**
	Total length of undisturbed drainage paths	0	0	2	0	**2**
	Biodiversity - measured in typical vegetation communities and habitat types	0	2	0	0	**2**
	Connectivity	0	0	2	0	**2**
	Water quality impact	0	0	0	0	**0**
	Native grassland retention area	0	0	0	0	**0**

Conclusion + Next Steps

The information gained from this workshop has provided a valuable foundation upon which the Project Team can build the study's next phase. The next meeting for the Working Group will the site visit, followed by the Indicator Confirmation, where the Project Team will propose a scenario and indicator framework.

Thank you to all participants for sharing their time, expertise, and insights!

02

Ricardo Ranch
Flood Fringe Study

Scenario Review Summary

Working Group #3 | June 19, 2019

02

Ricardo Ranch Flood Fringe Study

Ricardo Ranch Flood Fringe Study

Project Purpose

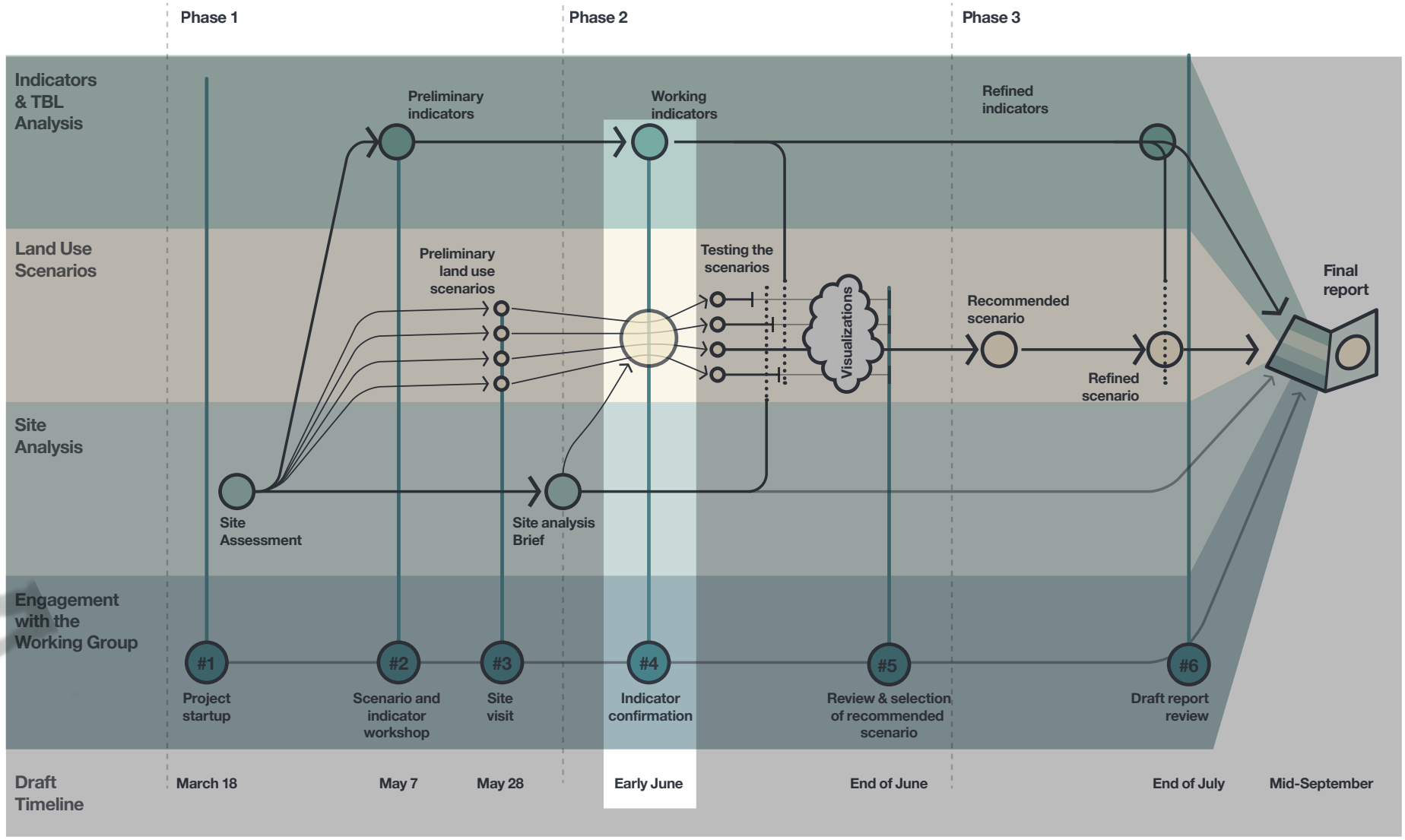
The Ricardo Ranch Flood Fringe Study convenes stakeholders to help establish and evaluate land use scenarios for the flood fringe of Ricardo Ranch, an area along the Bow River in southeast Calgary. The study will recommend a resilient land use profile for the site that balances environmental, economic, and social outcomes.

Working Group #3: Scenario Review

The third Working Group meeting, referred to as the “Scenario Review”, took place on June 19, 2019. Over ten participants from key stakeholder groups attended the session. The main purpose of the workshop was to gather thoughts and comments about the high level land use scenarios put forth by the Project Team. These comments will help direct the Project Team to refine the land use scenarios as they move forward in the Ricardo Ranch Flood Fringe Study. To do this, the workshop was provided with five worksheets illustrating the different scenarios. The group was then asked to provide “pros” and “cons” per scenario and mark up the drawings as much as they saw fit.

The information gathered from this workshop has been reviewed and is outlined in the following summary.

Project Workflow



Scenario Review

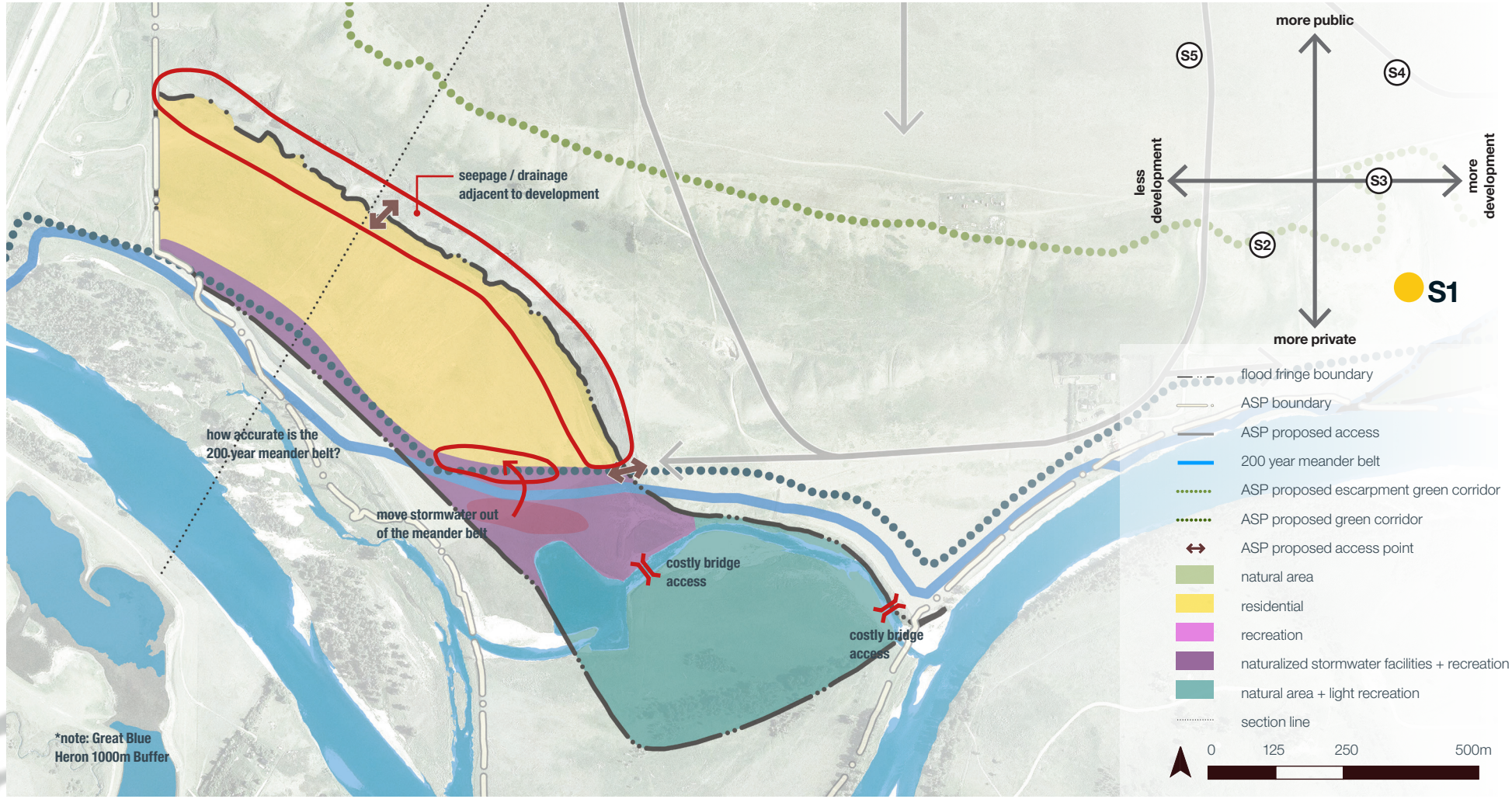
S1 - Full residential build out

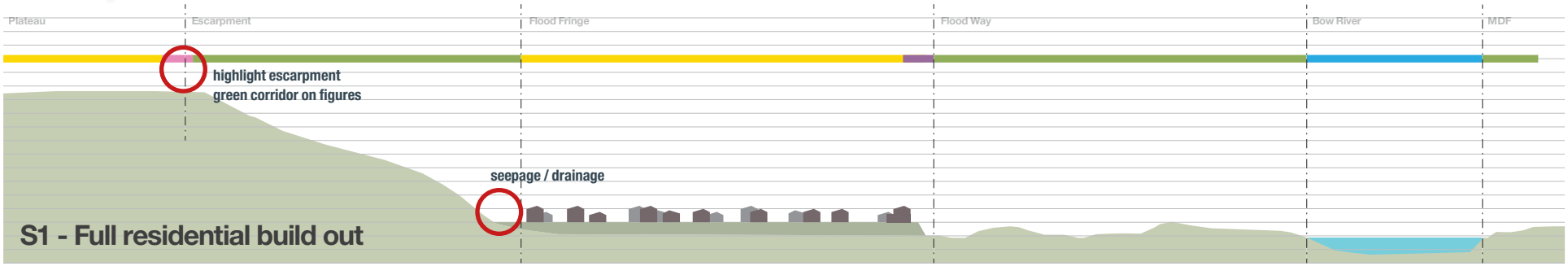
Pros

- Maximum revenue based on full development
- Maximum tax base is established for the City
- This is the last new opportunity to live by the river in Calgary
- Size
- Full development yield for the applicant
- Provides opportunities for public access to the natural areas and river
- Safety improvements: no more parking on Deerfoot for river access
- Highest and best use of vacant lands
- Provides desirable and valuable residential uses
- Lower density housing would minimize impact on wildlife habitat and movement corridor
- Utilizes over burden of fill from nearby developments
- Utilizes potentially undevelopable areas for stormwater and wetlands development close to natural areas
- Restorative exercise to bring lands closer to original grade- pre-gravel extraction
- Ricard Ranch is previously disturbed and of relatively low ecological value
- Development of residential may hinge on density to be economically viable
- Residential growth pays for development of site
- Growth funds infrastructure
- Lower conflict with development community
- City has no need for expenditure or investment of public funds
- No need for short-term investment of substantial public funds
- May result in less intensity of recreational use within the adjacent riparian belt than Scenario 3/4

Cons

- Any fill loses the wetlands
- What is the threshold for residential development? How much would be required to make Genesis Development be feasible?
- Bridges to southern area, both a pro and a con
- Consider slope setback
- Primarily private access to natural area, limited public access
- Quick transition from residential to river floodway, no natural buffer between recreation and flood way
- Cost of fill over such a large area
- Drainage issues due to slope seepage, adjacent to development
- Wildlife corridor/connectivity impacts, and potential conflicts
- Impacts to valley slope potentially due to fill extraction
- Topography is valued, this will change if topography is altered
- River valley aesthetics as Gateway entrance to City
- Public safety concerns in a flood event/ proximity
- Intensified recreational use in riparian zone
- Construction disturbance
- Potential financial liability to City in the long-term from potential future flood damages
- Climate change / flood resiliency uncertainties and impacts on home insurance costs
- Direct impacts to ungulate wintering range and river valley wildlife corridor functionality
- Potential for unmanaged recreational use in the sensitive inner riparian zone
- Potential for wildlife conflicts (e.g. bear/cougar/deer) and wildlife mortality due to new roads and higher traffic volumes
- Risks to stormwater facilities if these are situated within the 200 year meander belt zone as depicted in conceptual scenario example
- Drainage issues and flood potential due to slope seepage and build-out to base of valley slope
  Impacts to river valley upper slope and associated wildlife habitat/biodiversity and aesthetics due to fill extraction (to attain >2 million m^3 of fill) and cutting back valley slopes
- Noise and wildlife disruption (including likely impacts to great blue heron rookery) during construction
- Potential Bow River water quality contamination concerns due to development within a hydrologically connected alluvial aquifer
- Potential for impacting natural river migration and other hydrological / restoration processes by artificially raising the level of the flood fringe zone (effectively ‘straight jacketing’ the river)


seepage / drainage
adjacent to development
how accurate is the
200 year meander belt?
move stormwater out
of the meander belt
costly bridge
access
costly bridge
access
*note: Great Blue
Heron 1000m Buffer
more public
more private
less
development
more
development
S1
S2
S3
S4
S5
flood fringe boundary
ASP boundary
ASP proposed access
200 year meander belt
ASP proposed escarpment green corridor
ASP proposed green corridor
ASP proposed access point
natural area
residential
recreation
naturalized stormwater facilities + recreation
natural area + light recreation
section line
0
125
250
500m


Plateau
Escarpment
Flood Fringe
Flood Way
Bow River
MDF
highlight escarpment
green corridor on figures
seepage / drainage
S1 - Full residential build out

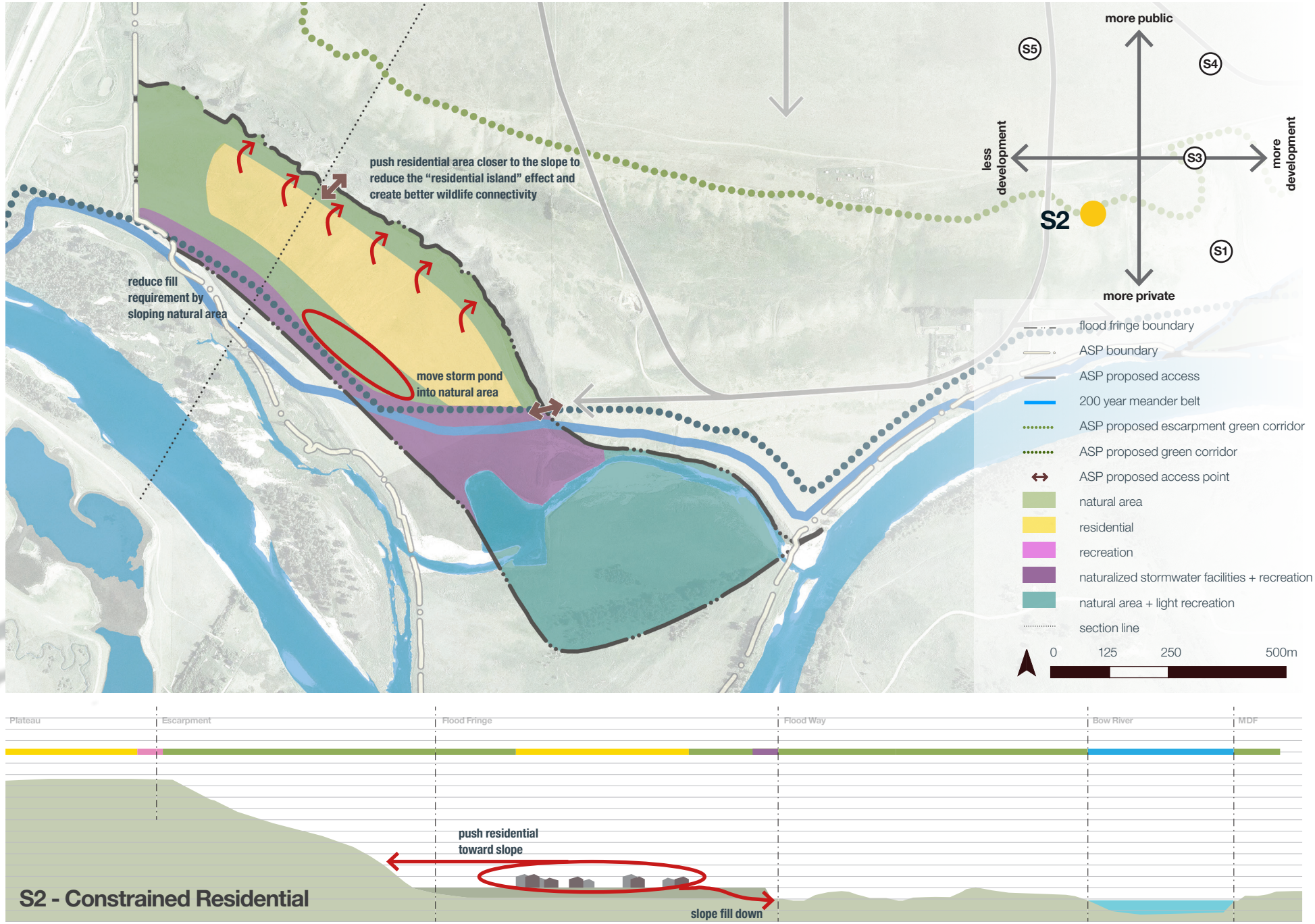
S2 - Constrained Residential Build Out

Pros

- Allows for some development
- Some development of seepage collection and drainage realigned at top of escarpment but probably doesn't need to be this large of an area
- Option for good transition from residential development
- Balance of natural and development- interesting opportunity for housing that integrates with nature
- Greater connectivity
- Greater buffer from the top of slope
- Greater buffer from floodway
- Potential for less fill required
- May allow for higher wildlife connectivity
- Allows for mitigation of toe slope/ valley slope seepage and drainage issue
- Allows for a wider buffer abusing sensitive riparian wildlife habitat corridors
- Potential to allow for seepage from the slopes- greater buffer from toe of slope
- May protect ephemeral streams better
- Potentially less fill required
- Potential for more wildlife/ungulate movement
- May allow for less potential wildlife conflicts by allowing for a wider naturalized buffer against the slope base and adjacent to the inner riparian belt
- May allow for improved mitigation of toe slope /valley slope seepage and drainage issues
- May result in less intensity of recreational use within the adjacent riparian belt than Scenario 3/4
- Likely requirement for less fill than S1

Cons

- Smaller area for economic return
- Increased cost to city for care and maintenance of public lands
- It seems likely that constrained development would not be viable unless the City was purchasing the "natural" land at full value
- Lots of fill required for minimal income gain
- Reduce volume of fill in flood fringe as not required for natural area
- Does the fill need to be full? [Drawn on section]
- Would be better off to push development back to escarpment toe and limit encroachment/fill into flood fringe
- Island of residential development is not a great option for habitat connectivity, and not a great option for development
- All natural area requires significant input (re-vegetation, fill) to get to "natural" state
- Some residual climate/flood/public safety risks
- More intense development may keep wildlife away- reduce conflicts
- Depends on Community design for wildlife conflict - bear, cougar
- Increased MR area removes other opportunities in areas of higher need in upper escarpment development
- Storm pond could be moved into natural area, could have berm around it
- Similar to S1
- Same cons as Scenario 1, just possibly lower extent?


more public
S5
S4
less development
more development
S3
S2
S1
more private
push residential area closer to the slope to reduce the "residential island" effect and create better wildlife connectivity
reduce fill requirement by sloping natural area
move storm pond into natural area
flood fringe boundary
ASP boundary
ASP proposed access
200 year meander belt
ASP proposed escarpment green corridor
ASP proposed green corridor
ASP proposed access point
natural area
residential
recreation
naturalized stormwater facilities + recreation
natural area + light recreation
section line
0
125
250
500m
Plateau
Escarpment
Flood Fringe
Flood Way
Bow River
MDF
push residential toward slope
slope fill down
S2 - Constrained Residential

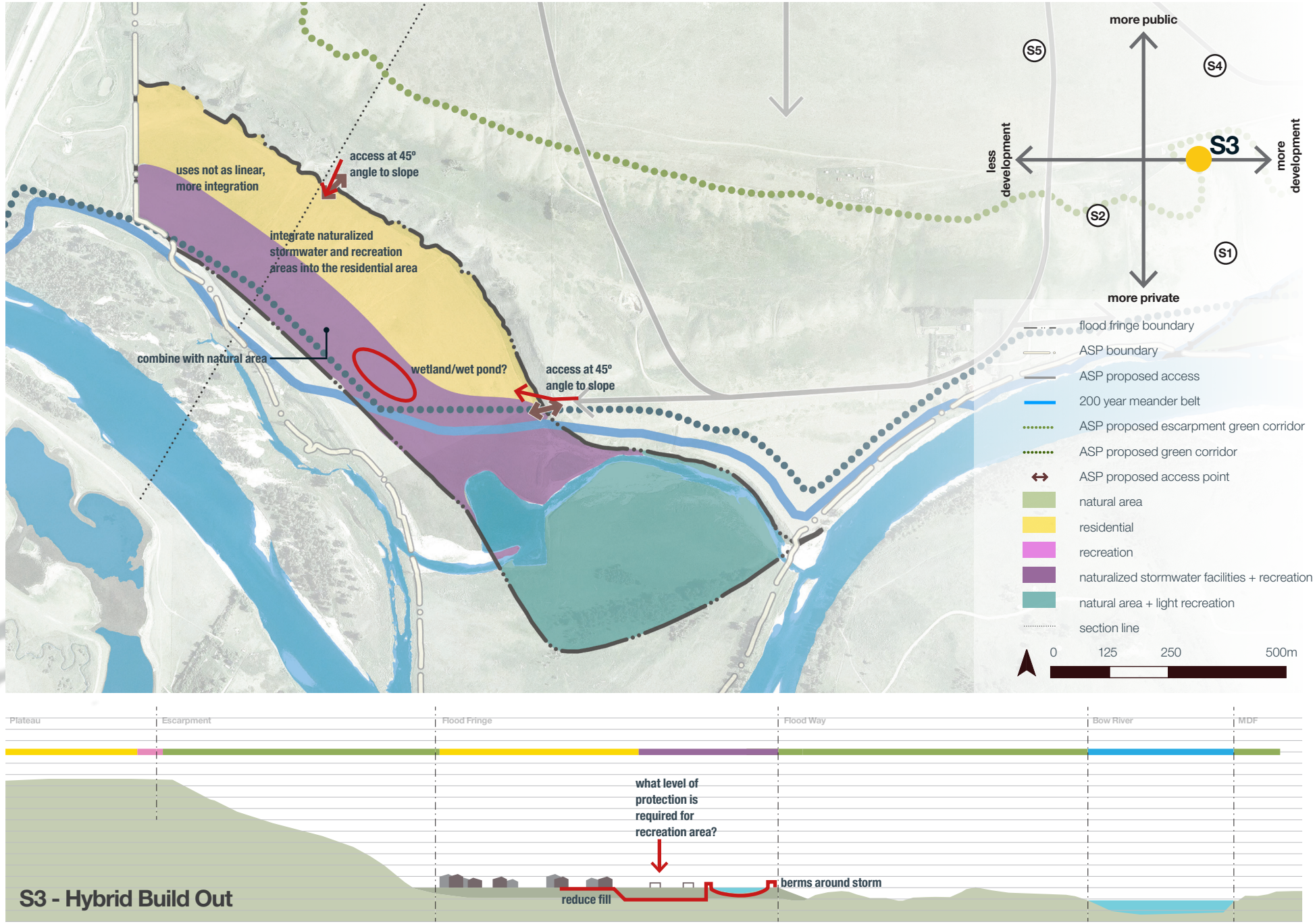
S3 - Hybrid Build Out

Pros

- Allows for some residential development
- Enhances river based activities
- Widens the natural area adjacent the river
- Residential development might justify cost of providing access to flood fringe
- Good transition from residential to recreation to river for movement (people and wildlife), and for biodiversity corridor
- Reduce grading, potentially less fill in purple zone as you get closer to the river
- Compact residential development, efficient servicing and roadway access
- Possibility to have purple zone to include natural area (combining with natural area)
- Good gradient of uses towards river
- Increased quality of regional pathway
- Allows for regional pathway development and supporting amenity features, benefiting larger public population rather than just local residents
- Seems like good balance between private and public as a river valley amenity
- More space for more intensive recreation in river valley, more recreation opportunity for multiple people
- Greater access for people from around the city
- Opportunity for more intensive recreation because Crown Land will be less intensive
- Less fill could be an option, depending on what these buildings are used for, could assume a 1:20 on a 1:50 year level of protection
- This option would remove the need for a large storm pond in the meander belt, instead there could be a long, dry pond or wetland in the naturalized recreation area
- Allows for regional pathway development and supporting amenity features, benefiting a larger public population than just local residents
- Possibly less fill requirements than S1
- Possibly reduced flood risks by allowing for a greater setback distance and less dense housing developments

Cons

- Arrangement of residential will most likely not be shaped so linearly
- Recreation could be “natural area”
- Pond location would naturally sit closer to the dug out versus Deerfoot trail
- Significant City cost to maintain and service a recreation complex
- It seems likely that naturalized stormwater recreation areas would be more integrated into the developed community
- Rather than filling out from the residential, the naturalized areas should be graded down to a lower elevation
- Recreation adjacent to development maybe by noisy, have lots of people, not sure if that’s going to be seen as amenity to adjacent residential
- Increase recreational use may negatively affect wildlife corridor, disrupt movement, displace migratory fowl. (Noise, light, users)
- Lower lot marketability for specific segments
- Similar flood/climate risks as S1, but to lower extent
- Similar to S1 (aesthetic impact, public safety risks)
- Potential noise pollution from recreational activity to residences, possibly reducing housing values
- Potential for higher density of recreational use, with more impacts to riparian habitats/sensitive wildlife (ex. great blue heron)
- Potential for more disturbance to wildlife
- Similar to S1
- May also result in increased noise levels from recreational use which could adversely impact adjacent property values
- Potential for higher density of recreational use with greater potential to impact sensitive riparian habitat/wildlife habitat or cause disturbance to wildlife movements (and higher conflict potential)


more public
S5
S4
S3
S2
S1
less development
more development
more private
uses not as linear, more integration
access at 45° angle to slope
integrate naturalized stormwater and recreation areas into the residential area
combine with natural area
wetland/wet pond?
access at 45° angle to slope
flood fringe boundary
ASP boundary
ASP proposed access
200 year meander belt
ASP proposed escarpment green corridor
ASP proposed green corridor
ASP proposed access point
natural area
residential
recreation
naturalized stormwater facilities + recreation
natural area + light recreation
section line
0
125
250
500m
Plateau
Escarpment
Flood Fringe
Flood Way
Bow River
MDF
what level of protection is required for recreation area?
reduce fill
berms around storm
S3 - Hybrid Build Out

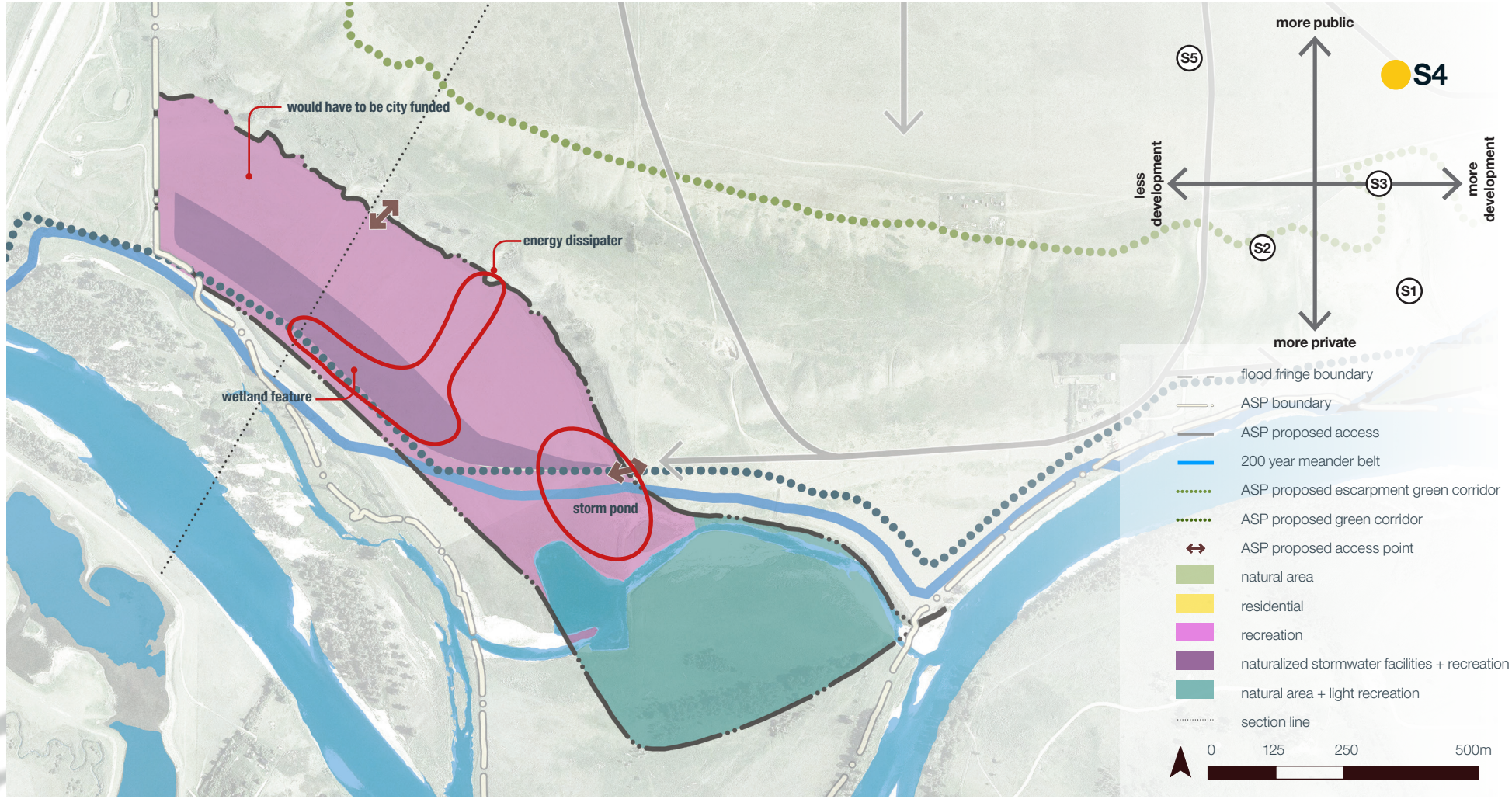
S4 - Full Recreation and Tourism Build Out

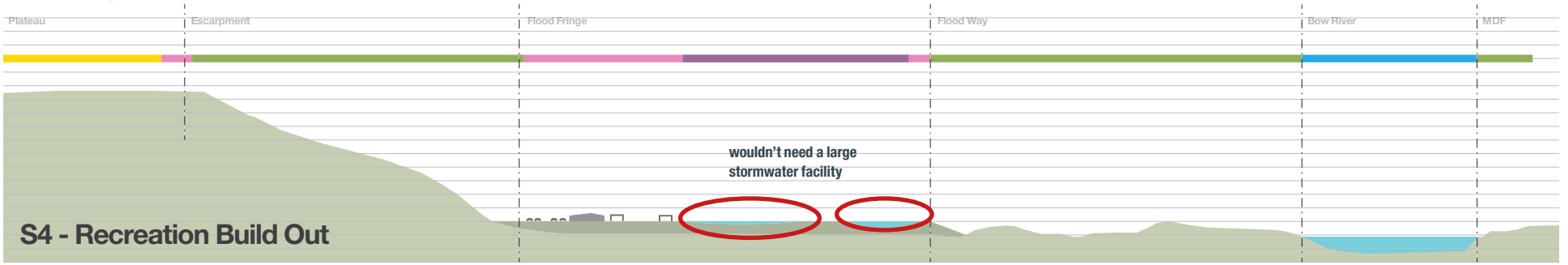
Pros

- Provides additional amenities for local and region citizens
- Public amenities developed in natural setting
- Destination regional recreation hub in SE Calgary
- Good for wildlife and possibly better for herons
- Long-term amenity value improvement to adjacent communities without noise/other impacts to directly adjacent homeowners (ex. recreational zone is spatially separated from residential zone)
- Environmental reserve title could reduce noise
- Less impact to residents (ex. Noise, busyness)
- Could have more buildings or other facilities within the flood fringe
- No storm facility in the meander belt, and may not need a large stormwater facility
- Linear storm facilities could maximize flow paths, increasing water quality
- Potential to build a naturalized wetland to capture local runoff
- Need to consider how impervious areas drain to wetland, potentially, could be located to the west and drain to the upstream end of the wetland
- Need to consider how the mid-terrace drains to the wetland, perhaps an open channel and energy dissipater?
- Could allow for better functional retention of wetlands and integrated 'naturalized' habitats within the recreational build-out area with benefits to wildlife habitat and biodiversity as well as stormwater runoff filtration
- Much reduced flood damage risk to housing developments and associated infrastructure
- Reduced public safety risk to home owners
- Allows for regional pathway development and supporting amenity features, benefiting a larger public population than just local residents
- Possibly less fill requirements than S1

Cons

- Is there demand for recreation with such close proximity to Seton YMCA and the new high school field facilities? Potential redundancy and/or saturation for recreational use in the area?
- Where is the closest Regional Park? What gaps in recreation exist in the adjacent communities? Is there a demand?
- Significant City expenditure
  - Requires significant public cost to purchase, service and maintain
  - Cost to City to purchase the land and pay for infrastructure
  - Significant public costs to acquire land, develop access down escarpment
  - Requires large land transfer
  - No income from tax base
  - High public costs to City if recreational build-out plan has to be paid for by the City (including land cost/infrastructure costs)
- Environmental + Wildlife Disruption
  - High concentration of public activity adjacent to the Great Blue Heron colony, noise may disturb the herons
  - Not overly compatible with natural areas/wildlife habitat. Intense use creates noise, light pollution
  - Potential for higher density of recreational use with greater potential to cause disturbance or disruption of wildlife movement and with greater potential to impact sensitive riparian habitat/wildlife habitat
  - Increases intensity to sensitive areas
- This scenario doesn't support direct river access (ex. boat launch)
- Requires significant transportation needs
- Increased traffic potential
- Potential for noise disturbance
- More conflict politically and with landowner?
- Need for fill and impacts from that potentially to river valley landforms
- Benefits would potentially be outweighed by the need for the same level of fill to be brought in with potential impacts to the river valley
- Environmental and aesthetic impacts resulting from having to import fill if this results in cutting back upper valley slopes
- Storm layer needs to be adjusted, pond will reside closer to the dug-out
- Not best or highest use





S4 - Recreation Build Out

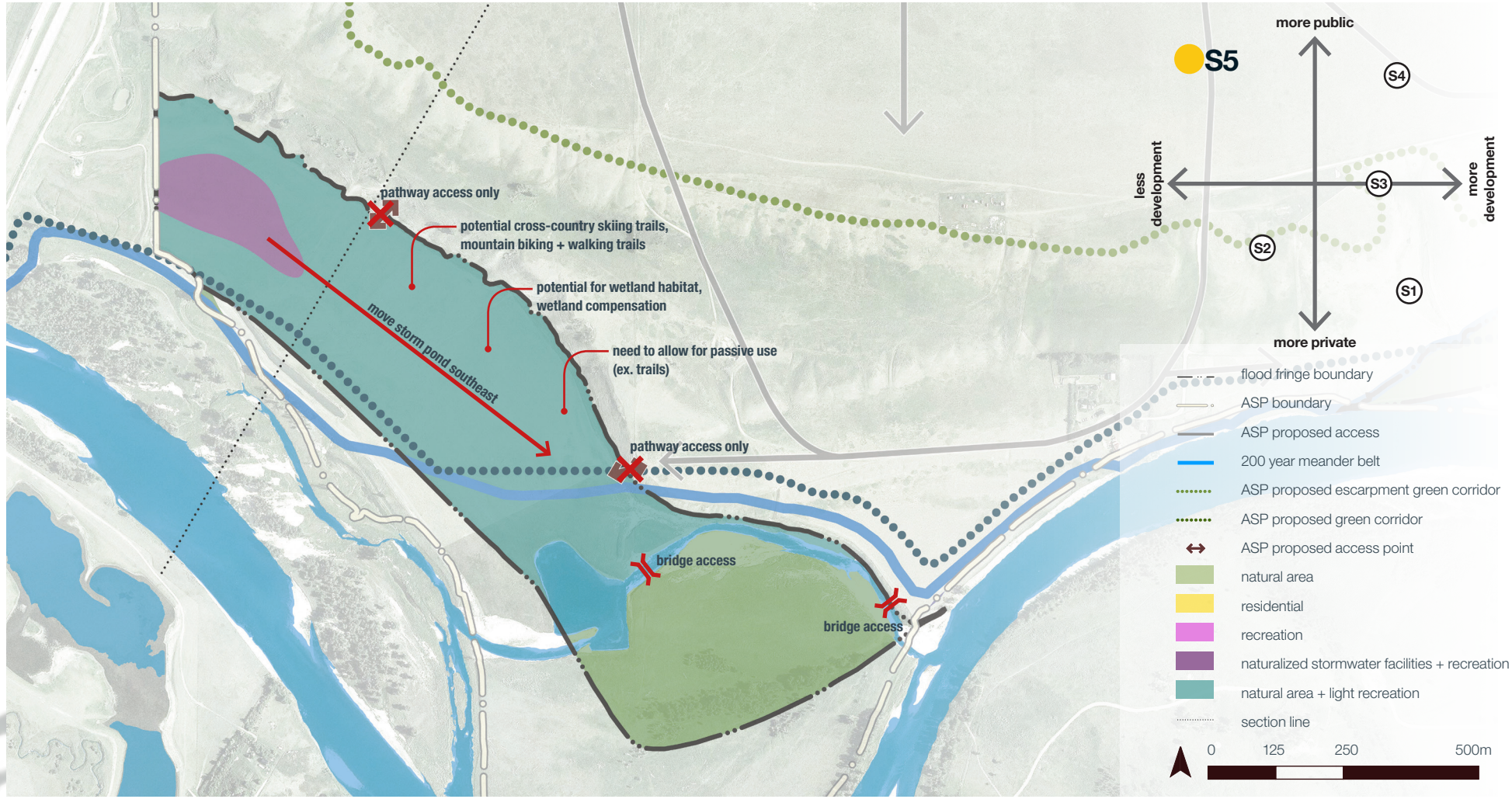
S5 - Restoration

Pros

- Potential to create mountain biking and pedestrian trails
- Potential to create winter cross-country skiing trails
- Need to allow for passive use (trails, etc.)
- Large natural park for area residents, with a regional draw
- Potential for just pathways/trails down to the natural area, rather than access roads
- Restored habitat could be of high value for wildlife and light-use access, this provides value to public without high impact costs for development
- Best for ecological networks and biodiversity
- Opportunities for a different experience for “nature in the city”
- No fill requirement, less impact
- Allows for retention of valuable wildlife movement corridor/biodiversity/flood climate change resiliency
- Allows for retention of a valuable wildlife movement corridor and other ecological benefits
- Allows for natural riverine processes and ecological functions to be better protected and enhanced
- Offers better potential to protect water quality in the Bow River (avoided development within the alluvial aquifer zone)
- Opportunity to possibly use City of Calgary Wetland Compensation Funds for land purchase off-set or to restore functional wetland habitat within the City limits to offset major loss of wetlands city-wide
- Offers opportunity for unique low-impact environmental education / cultural education temporary or seasonal facilities / experiences (e.g. teepee camping).
- Less potential to adversely impact heron rookery
- Better alignment with City environmental and resiliency policies as outlined in the MDP, Riparian Action Program, Riparian Strategy, Resiliency Strategy, Biodiversity
- Best use of wetland designated funds?
- Allow for land purchase opportunity rising City’s wetland compensation funds
- Lowest flood risk
- Zero public safety / insurance risks / liability concerns in perpetuity (greater flood resiliency in the long-term even with climate change uncertainties)
- Lowest flood risk
- Potential for wetland habitat, wetland compensation
- No stormwater facility required

Cons

- Cost of restoration for riparian areas
- How would the public cost to restore be justified? Would this scenario work only if the area was deemed o be unstable for development?
- Entire area requires grading and re-vegetation to get to “natural” condition, with no income to pay for the restoration
- City cost to purchase
- City cost to maintain
- City cost to restore
- High cost to the city and the public
- Public expense to acquire but not to build
- Public expenditure to acquire and restore
- Relocate stormwater southeast
- How important is this land for the river meander and flood fluctuations?
- Increase with MR erodes MR uses in remaining plan area. With high OS requirements
- Not best use for area
- Need for control of recreation use access and impacts (ex. some designated pathways needed)
- Who would use this area?
- Community or is it a destination area? Parking not provided in flood fringe area, could be an issue for the upper plateau if people are attracted

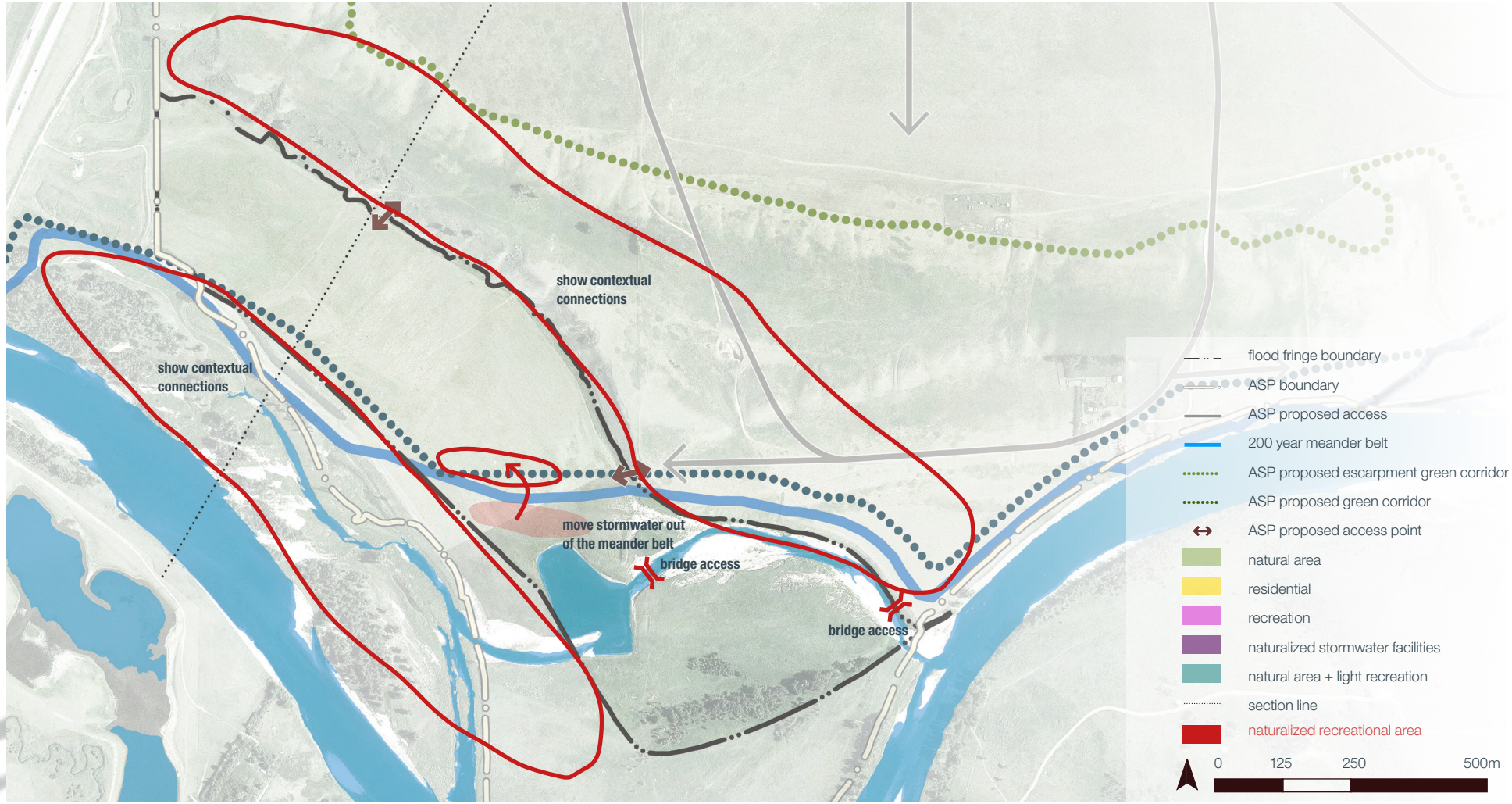

pathway access only
potential cross-country skiing trails, mountain biking + walking trails
potential for wetland habitat, wetland compensation
move storm pond southeast
need to allow for passive use (ex. trails)
pathway access only
bridge access
bridge access
more public
S5
S4
S3
S2
S1
less development
more development
more private
flood fringe boundary
ASP boundary
ASP proposed access
200 year meander belt
ASP proposed escarpment green corridor
ASP proposed green corridor
ASP proposed access point
natural area
residential
recreation
naturalized stormwater facilities + recreation
natural area + light recreation
section line
0
125
250
500m


Plateau
Escarpment
Flood Fringe
Flood Way
Bow River
MDF
S5 - Restoration

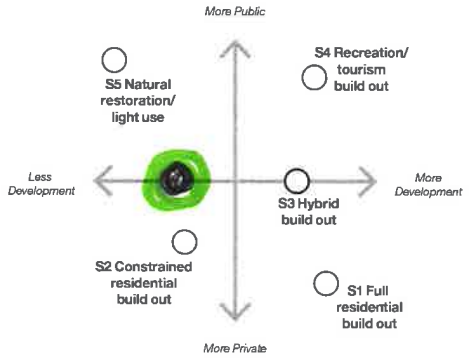
All Scenarios

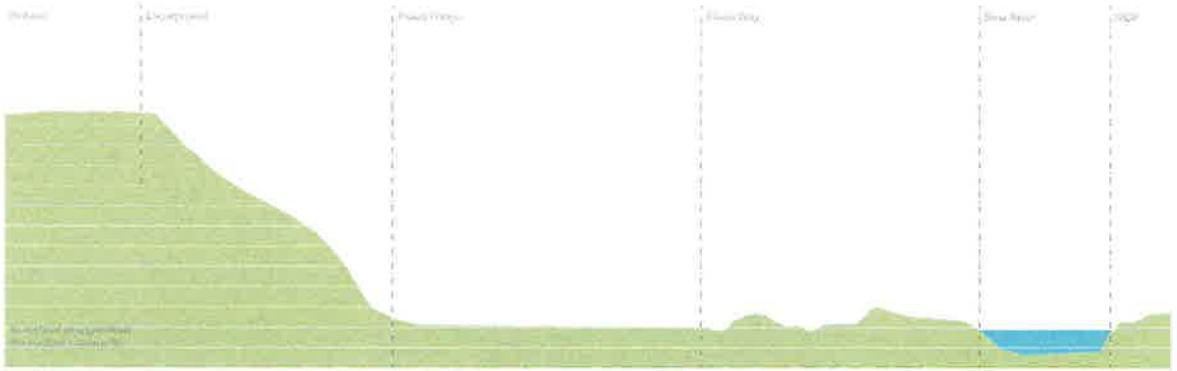
Questions and Considerations

- All scenarios should highlight the connection to the retained slopes that sit above the fringe
- Will storm pond service mid-terrace development?
- Storm pond (see Area Structure Plan Map 11)- it looks like pond is shown within meander belt, test vulnerability of scenario to this assumption
- How accurate is the 1:200 year meander belt? Test scenarios to vulnerability of this assumption
- Should the river valley be a public amenity?
- Maybe don't do intense recreation if boat launch is in the Crown land?
- Divide "naturalized stormwater facilities + recreation" land use:
  - Naturalized stormwater facility (dry pond, wet pond, wetland)
  - Naturalized recreational area
- Any fill loses the wetlands
- Consider slope setback


show contextual
connections
show contextual
connections
move stormwater out
of the meander belt
bridge access
bridge access
flood fringe boundary
ASP boundary
ASP proposed access
200 year meander belt
ASP proposed escarpment green corridor
ASP proposed green corridor
ASP proposed access point
natural area
residential
recreation
naturalized stormwater facilities
natural area + light recreation
section line
naturalized recreational area
0
125
250
500m

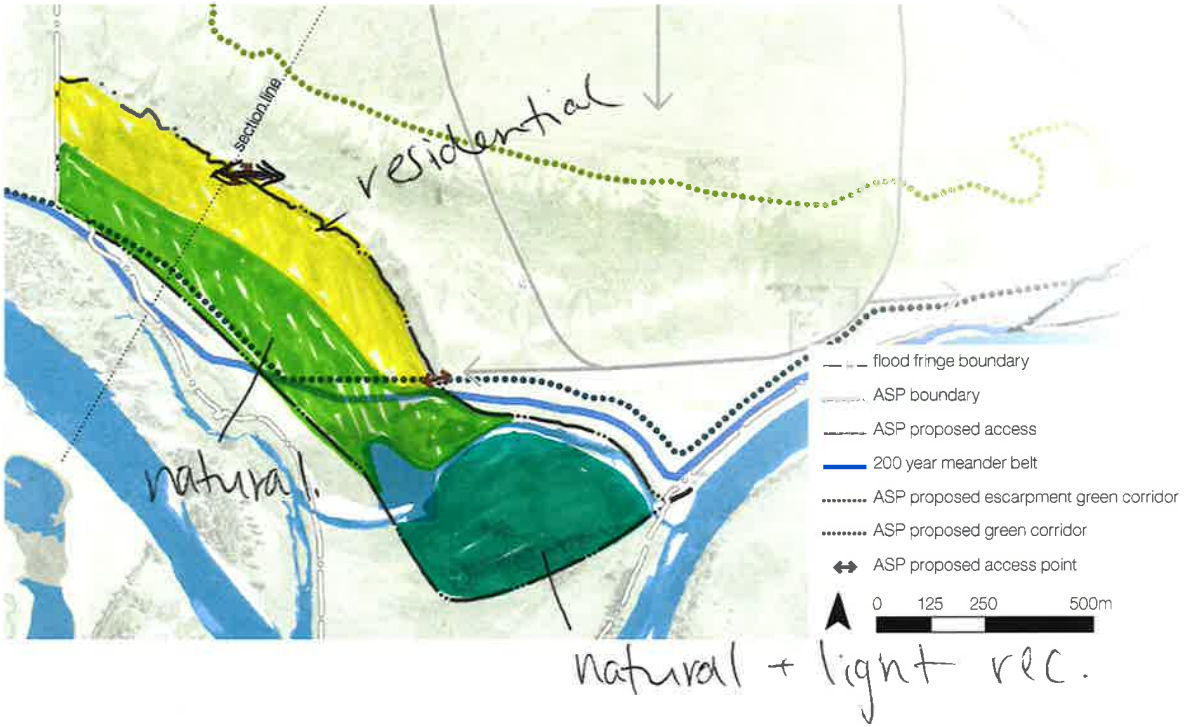
New Drawn Scenarios



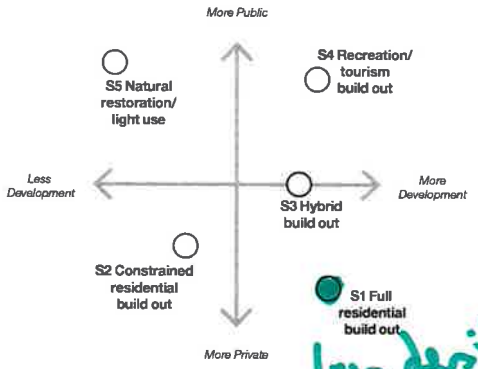


Comments:

Hybrid of build out + natural



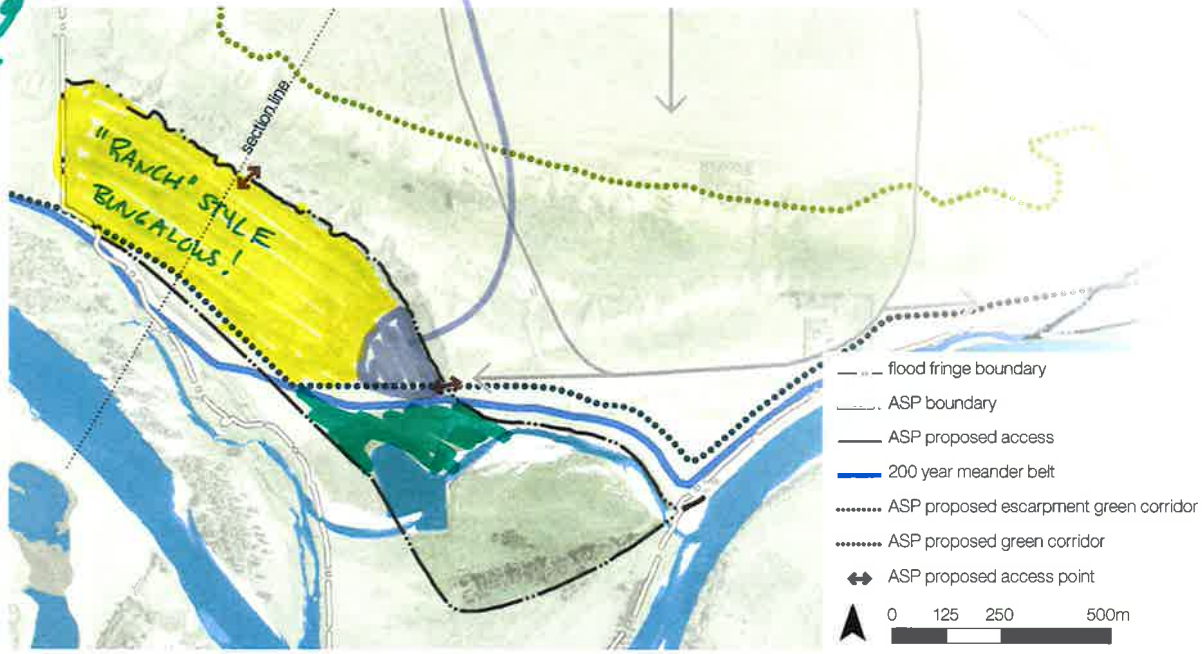
natural + light rec.



low density
no stair
in meander
belt

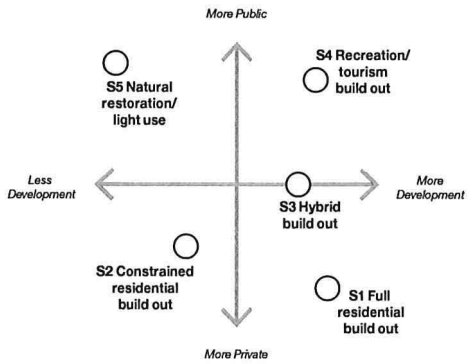
Comments:

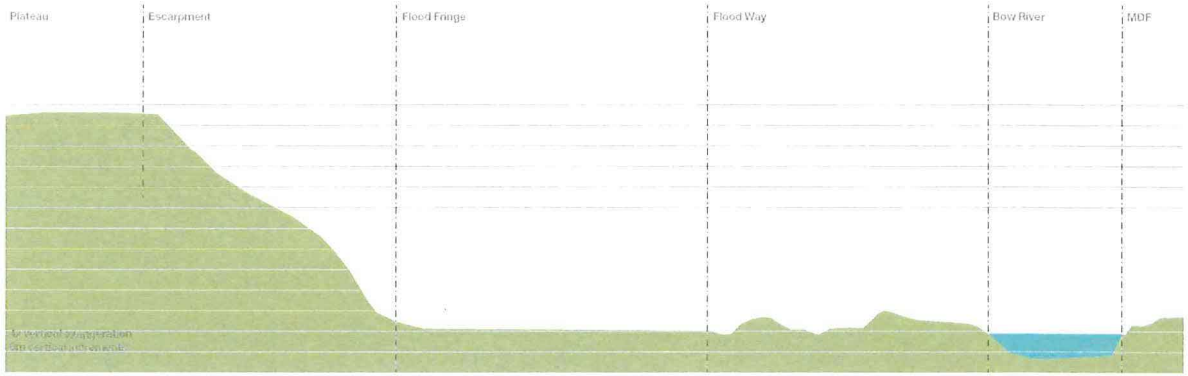
~ 4 ha pond.



02 Ricardo Ranch Flood Fringe Study

02 Ricardo Ranch Flood Fringe Study

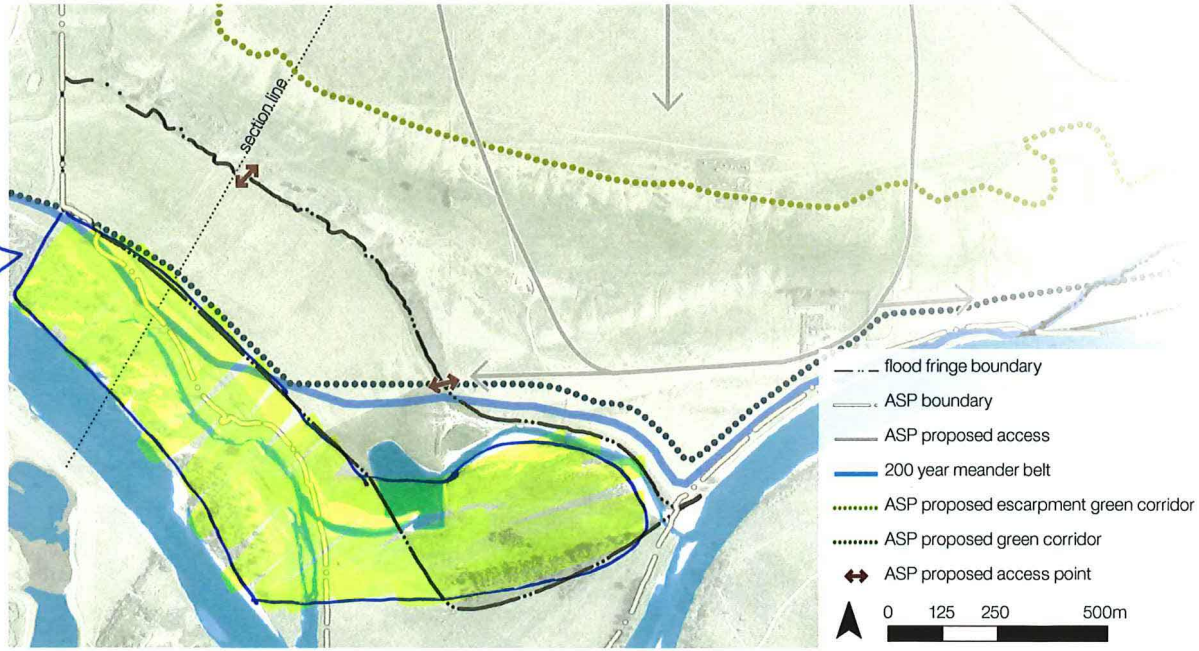




Comments:

Regional park w/ sustainable amenities best suited in highlighted area. →

Brookfield could assist with improving this area for pedestrian access and picnic sites.



O2 **Ricardo Ranch Flood Fringe Study**

Conclusion + Next Steps

The information gained from this workshop has provided a valuable foundation upon which the Project Team can refine the scenarios and build the next phase of the study. The next meeting for the Working Group will be to review and select a recommended scenario.

Thank you to all participants for sharing their time, expertise, and insights

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Ricardo Ranch
Flood Fringe Study

Indicator Scorecard Summary

Working Group #4 | July 22, 2019

02

Ricardo Ranch Flood Fringe Study

Ricardo Ranch Flood Fringe Study

Project Purpose

The Ricardo Ranch Flood Fringe Study convenes stakeholders to help establish and evaluate land use scenarios for the flood fringe of Ricardo Ranch, an area along the Bow River in southeast Calgary. The study will recommend a resilient land use profile for the site that balances environmental, economic, and social outcomes.

Working Group #4: Indicator Scorecard

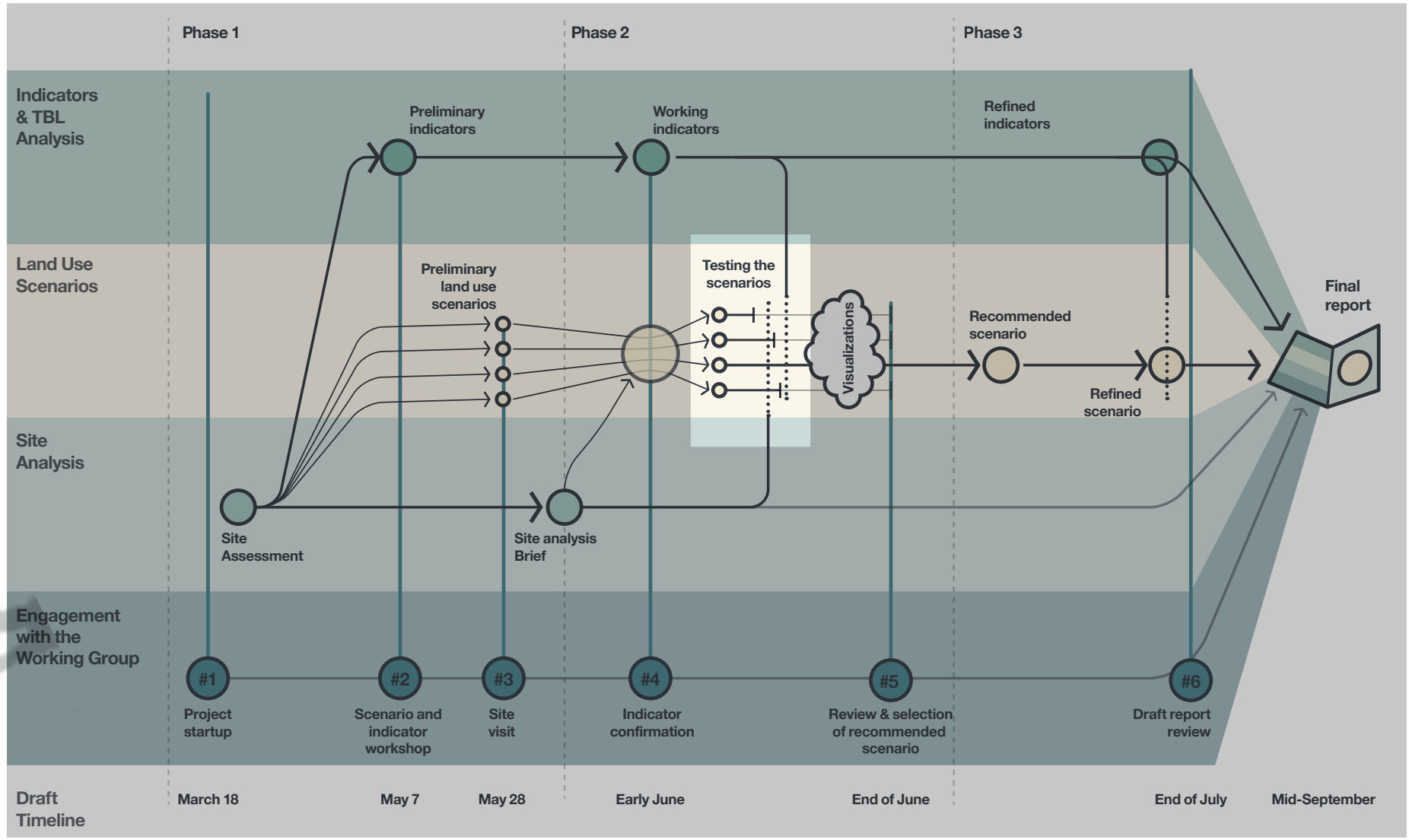
The fourth Working Group meeting, referred to as the "Indicator Scorecard," took place on July 22, 2019. Over 10 participants from key stakeholder groups attended the session. The main purpose of the workshop was to gather thoughts and comments about the draft scorecard indicators and scenarios as the Project Team experimented with the scorecard prototype.

The workshop was divided into two main exercises:

» Scorecard Part 1: Weight Adjustment
» Scorecard Part 2: Exploration

The information gathered from this workshop has been reviewed and is outlined in the following summary.

Project Workflow



Indicator Scorecard

Scorecard Part 1: Weight Adjustment

Purpose

The main goal of this exercise was to assess the indicators and their associated weighting, in isolation from the scenarios. To do so, the working group was divided into groups and each group equipped with a laptop with access to the working scorecard file. The scorecard file was arranged to display the Indicator, the associated TBL domain, the desired performance statement, and a weight. Based on best practice and professional knowledge, each group was asked to assign an appropriate weight to each indicator, with the cumulative weight of all the indicators adding up to 100. At the end of this exercise a summary was displayed, reflecting the ranking of each scenario based on these new weights.

Results

This exercise was successful because the groups analyzed the indicators in isolation from the scenarios, enabling the indicators to speak for themselves and the ranking of the scenarios to respond to the changing weights. When all the groups had completed their weight adjustment, a real-time summary was revealed, showcasing the ranking of each scenario, per group given the new weights. Scenario 2 ranked first for groups B, C, and D despite having varying weightings. Scenario 5 and 6 scored similarly for Groups B, C, and D as well.

Additional comments were provided throughout the exercise regarding the wording of indicators, potential redundancy, missing indicators, as well as potential for some indicators to be removed due to existing provincial and/or municipal policy mandates.

		The statement of desired performance sets out the target state for the indicator. Each scenario will be scored based on the degree to which its supports or undermines this performance. The relative importance of these indicators will be applied in a separate weighting process.	
Indicator	**TBL Domain**	**Desired Performance**	**Group A Weightings**
Impacts to Escarpment	Environmental	The scenario has no direct impact on the escarpment (including the slope faces, wetlands, drainage channels and vegetation). Lower impact = higher score	**1**
Impacts to Riparian Habitat	Environmental	The scenario does not directly or indirectly contribute to a reduction in riparian habitat in the flood fringe or the floodway. (For example: increased trailing and recreational use in the floodway as a result of increased public / resident access in the flood fringe.) Lower impact = higher score	**1**
Impacts to Wildlife Connectivity	Environmental	The scenario does not directly or indirectly distrupt key wildlife corridors. (Consider physical barriers as well as noise, light and other anthropogenic disturbances.) Lower impact = higher score	**1**
Impacts to Wetlands	Environmental	The scenario results in a neutral or net positive impact on wetland habitat. (This includes greater wetland coverage and/or higher quality habitat.) More positive impact = higher score	**1**
Area of Impervious Surface	Environmental	Scenario minimizes the addition of impervious surfaces.	**1**
Environmental Impacts During Construction	Environmental	Implementation of the scenario results in minimal temporary impacts from construction (wildlife disturbance, noise, pollution, soil compaction, etc.). Lower impact = higher score	**1**
Visual Appeal Public	Social	The scenario creates formal and informal views into park spaces, natural areas and to the river from publicly accessible locations. More views = higher score	**1**
Visual Appeal Resident	Social	The scenario creates formal and informal opportunities for residents to enjoy views to park spaces, natural areas and the river from residential development in the flood fringe and adjacent table lands. More views = higher score	**1**
Local Accessibility of Open Space	Social	The scenario results in greater access to open space for residents in the flood fringe and adjacent table lands. Greater accessibility = higher score	**1**
Regional Accessiblity of Open Space	Social	The scenario results in greater public access to open space in the flood fringe and floodway for people living outside the study area. Greater public accessibility = higher score	**1**
Access to Spaces That Can Accommodate Cultural Uses, Events and Celebration	Social	The scenario includes a mix of land uses and open spaces that are appropriate for cultural uses, events and celebration.	**1**
Local River Access	Social	The scenario facilitates pedestrian access to the river for residents in the flood fringe and adjacent table lands. Greater accessibility = higher score	**1**
Regional River Access	Social	The scenario facilitates pedestrian access to the river from the flood fringe for people living outside the study area. Greater accessibility = higher score	**1**
Human Impacts due to Flooding	Social	The scenario minimizes the safety hazards and trauma that could result from a major flood event. Less impacts = higher score	**1**
Land Value and Property Enhancement (Inside Boundaries)	Economic	The scenario increases the land value inside the flood fringe boundaries. Higher value = higher score	**1**
Land Value and Property Enhancement (Adjacent Land)	Economic	The scenario increases the land value in the adjacent table lands and plateaus. Higher value = higher score	**1**
Infrastructure Flood Damage Costs	Economic	The scenario minimizes costs associated with infrastructure loss or damage that would be expected as a result of a major flood event. Lower cost = higher score	**1**
Business and Tourism Development Impacts	Economic	The scenario supports business and tourism development in the flood fringe and adjacent lands. More tourism/business = higher score	**1**
Total Public Cost of Construction and Maintenance	Economic	The scenario minimizes the public cost of construction and and the operational carrying cost of development. Lower cost = higher score	**1**
		TOTAL WEIGHT (should be 100)	**19**
	Total Indicator Count by Domain		**Total Indicator Weight by Domain**
Environmental	6	**Environmental**	6
Social	8	**Social**	8
Economic	5	**Economic**	5

Figure 1. Pre-Exercise Scorecard

Indicator	TBL Domain	A Weighting		B Weighting		C Weighting		D Weighting	
Impacts to Escarpment	Environmental	8		3		10		3	
Impacts to Riparian Habitat	Environmental	6		7		2		9	
Impacts to Wildlife Connectivity	Environmental	8		7		7		3	
Impacts to Wetlands	Environmental	4		3		1		3	
Area of Impervious Surface	Environmental	2		5		3		3	
Environmental Impacts During Construction	Environmental	6		5		1		3	
Visual Appeal Public	Social	6		7		10		3	
Visual Appeal Resident	Social	4		4		3		3	
Local Accessibility of Open Space	Social	1		7		5		9	
Regional Accessiblity of Open Space	Social	3		6		7		3	
Access to Spaces That Can Accommodate Cultural Uses, Events and Celebration	Social	2		3		2		3	
Local River Access	Social	1		6		4		9	
Regional River Access	Social	3		5		4		3	
Human Impacts due to Flooding	Social	12		5		10		5	
Land Value and Property Enhancement (Inside Boundaries)	Economic	4		7		10		10	
Land Value and Property Enhancement (Adjacent Land)	Economic	7		6		1		9	
Infrastructure Flood Damage Costs	Economic	10		6		10		6	
Business and Tourism Development Impacts	Economic	5		3		5		4	
Total Public Cost of Construction and Maintenance	Economic	8		5		5		9	
	Total Indicator Count by Domain								
Environmental	6	34		30		24		24	
Social	8	32		43		45		38	
Economic	5	34		27		31		38	
		Score	Rank	Score	Rank	Score	Rank	Score	Rank
	Scenario 0	29	2	10.5	7	17.5	6	-2	8
	Scenario 1	-8	7	12.5	6	13.5	7	19.5	5
	Scenario 2	23.5	3	41.5	1	44.5	1	46	1
	Scenario 3	-2	6	19.5	4	20	4	23.5	4
	Scenario 4	4	5	13	5	18.5	5	9.5	7
	Scenario 5	48.5	1	31.5	2	28	3	25	3
	Scenario 6	13.5	4	31	3	29	2	40	2
	Scenario 7	-16.5	8	0.5	8	-2	8	13.5	6

Figure 2. Exercise 1 Summary

Scorecard Part 2: Exploration

Purpose

Exercise 1 tasked the working group with choosing appropriate weights for each indicator based on their professional knowledge and best practices. For Exercise 2 the working group was asked to push the scorecard further. They were asked to try to "beat the scorecard," attempting to make one scenario out-rank another to see if any indicators were redundant, too strong, not strong enough, or not impacting the scenarios in strange or expected ways. The changing scenario ranking was displayed in real time, allowing the working group to play with the scorecard and explore which indicators affected what.

The scenarios were also subject to scrutiny during this exercise. The working group provided answers to questions such as; were the scenarios different enough from each other? Were the land uses clear? And could any scenarios be let go?

Results

The group suggested that S2 and S6 could potentially be combined, as well as S1 and S3, as these pairings did not differ enough during scoring. Additional Comments are summarized in the table below.

Indicator	TBL	Desired Performance	Comment
Impacts to riparian habitat	Environmental	The scenario does not directly or indirectly contribute to a reduction in riparian habitat in the flood fringe or the floodway. (For example: increased trailing and recreational use in the floodway as a result of increased public / resident access in the flood fringe.) Lower impact = higher score	Recommend changing "reduction" to "increase" or "improve" because of the limited riparian habitat currently existing within the flood fringe.
Impacts to Wetlands	Environmental	The scenario results in a neutral or net positive impact on wetland habitat. (This includes greater wetland coverage and/or higher quality habitat.) More positive impact = higher score	There is a policy of no net loss. Therefore this must be met, so we felt that this was going to occur in all scenarios.
Environmental Impacts During Construction	Environmental	Implementation of the scenario results in minimal temporary impacts from construction (wildlife disturbance, noise, pollution, soil compaction, etc.). Lower impact = higher score	Policy of minimum disturbance during construction that MUST be followed. Which includes 1000m setback during construction for herons during breeding season. This would need to occur across all scenarios.
Local Accessibility of Open Space	Social	The scenario results in greater access to open space for residents in the flood fringe and adjacent table lands. Greater accessibility = higher score	Overlaps with "Local River Access" indicator. Combine?
Local River Access	Social	The scenario facilitates pedestrian access to the river for residents in the flood fringe and adjacent table lands. Greater accessibility = higher score	Overlaps with "Local Accessibility of Open Space" indicator. Combine?

Conclusion + Next Steps

The information gathered from these two exercises were reviewed and have provided valuable direction to strengthen the existing scenarios, and the scorecard indicators, desired performances, and weights moving forward.

The next step will be to use the refined scorecard to analyze the finalized scenarios and provide recommendations for the Ricardo Ranch Flood Fringe Study.

02

Ricardo Ranch
Flood Fringe Study